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Photographing of Disease Symptoms of Leaves

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MACROPHOTOGRAPHY has acquired increasing importance and significance in recent years as a definite necessity in agricultural research. New equipment and techniques now make available to the scientist photographs which not only catalogue progress of investigations, but actually assist in research projects as permanent, authentic records and controls; supplanting drawings and text which rely heavily on personal interpretation.

This brief article will attempt to illustrate three techniques for the photographing of diseased Sour Cherry leaf (Leaf Spot Fungus, *Coccomyces hiemalis*). A leaf has been used as an interesting comparison between methods, and it will be evident that these techniques are not restricted to the photographing of this type of material alone, but can be applied to a variety of other projects involving the photography of small objects or small areas.

Equipment

The basic equipment used was a 35 mm Exakta fitted with a Kilfitt bellows extension, supported by a tripod, as shown in the illustrations. The material to be photographed is supported by ordinary laboratory stands and clamps. These supports offer an infinite variety of adjustments, and it is extremely difficult to handle this type of project speedily and efficiently without them. These set-ups are constructed for easy disassembly, as most of the equipment is used for many different types of work. All of the photographs were taken with electronic flash, which, by its extremely short exposure, eliminates the problem of heat which is encountered with the long exposures required for most macro work; particularly with delicate material.

The Mighty Light Close-Up Ring was used for Fig. 2, and is of the 450 volt variety. Figs. 4, 6 and 7 were taken with an Ascor AB904 having an output of 7500 B.C.P.S., and using one head only.

The Close-up Ring when used as in Fig. 1, produces a flattened result, lacking in texture and contour (Fig. 2). This quality might be desirable for some

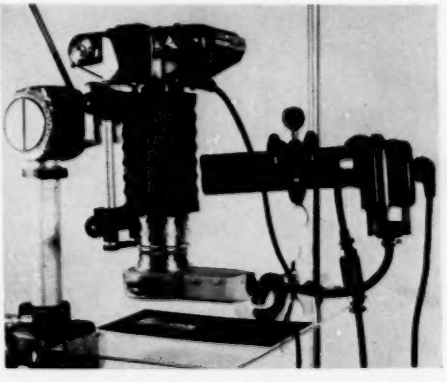

Fig. 1. Close-Up Ring set-up (reflected).

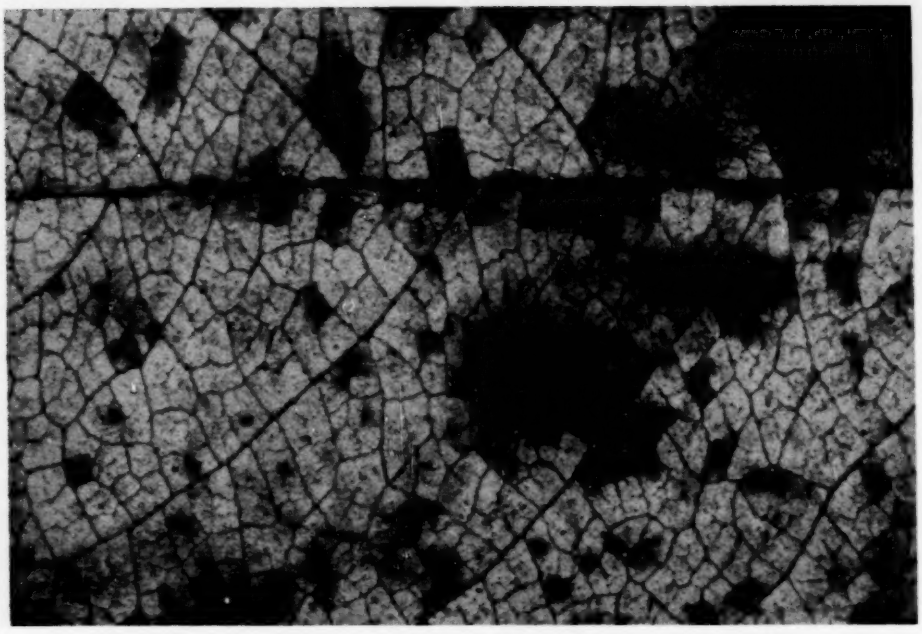

Fig. 2. Leaf section using close-up ring. Print magnification 5.5X.

subjects however. The Close-Up Ring was used, in this instance, as a means of comparison only and to illustrate its possible use under other circumstances, using the same set-up. If, for instance, the material to be photographed has any depth, and important detail would be obsecured by shadows, then the Close-Up Ring could possibly be the only suitable light source.

It will be noticed in Fig. 3 that a black shield is attached to the lens by means of an adapter ring; also, that the subject is resting on glass and the background is dropped well below the subject. The elimination of objectionable edge shadow, which occurs if the area to be photographed is near the edge of the material, may be accomplished by placing the subject on glass rather than an opaque background, and having the light angled to project the shadow of the subject outside the picture area. This leaves the background free of shadows and it is illuminated by the spill from the light source. However, reflection from the lens and camera body sometimes occur on the glass even when it is tilted, and some material will not remain stationary on a tilted surface, hence, the shield on the lens. This is made of metal, painted flat

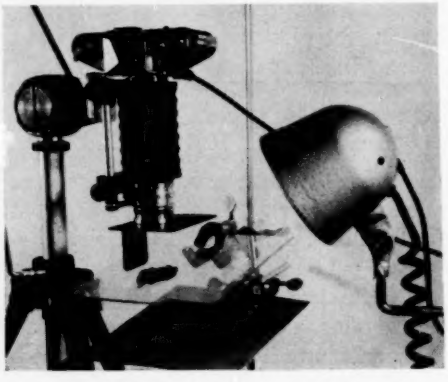

Fig. 3. Single light set-up (reflected).

black, and is of adequate size to cover your usual working area. The apron is bent at right angles and cuts out reflections from the bellows tracks when working with the lens closer to the camera body. Although this attachment was not required for the photographing of Fig. 4 it is included here as an aid for photographing such subjects as described above.

Reflected — Close-Up Ring

As illustrated in Fig. 1, a 50 mm. lens was used and the indicator arrow on the Kilfitt bellows was set at the engraved 4 on the track. (The illustrations of equipment all show the bellows at maximum extension). At this extension, a 50 mm. lens gives a magnification of 1.1:1, on the film, as indicated in Table 1. The entire table is given here for the benefit of those using a variety of lenses requiring different magnifications. A 50 mm. lens was used for all these examples to maintain consistency. The versatility of the stands and clamps for support of both the material to be photographed and the Close-Up Ring condenser is quite evident.

Exposures were made at f.22 on Kodak Panatomic-X. The film was then processed in Microdol for 6 minutes at 68° F. The result provided by this method, Fig. 2, although showing the surface sharply, and quite adequately for some purposes, lacks relief.

Reflected — Single Head

Fig. 3 shows a set-up for a method which also employs reflected light, but here a single source is used to accentuate the texture of the surface of the subject. The light was placed ten inches from the material and at a low angle, to "hit the high spots", rather than flood the whole

Fig. 4. Leaf section using single light. Print magnification 5.5X.

area. Of course, this can be carried to extremes, and if the angle is such as to achieve nothing but relief and obscure detail, then little has been accomplished. A white paper reflector may be used to soften hard shadows, if they exist. The "skimming" effect desired will be adversely affected, however, if a second light is placed opposite the first.

The viewing light was a No. 1 Photoflood, which was raised and lowered until the correct balance was obtained, still maintaining detail and contrast in the infected areas but definitely showing the surface texture of the leaf, Fig. 4. The same magnification setting of 1.1:1 was used and the same exposure was required. Obviously, these exposures will serve only as a guide to anyone interested in duplicating these set-ups, as no two subjects reflect the same amount of light, and requests are sometimes received for photographs at specified magnifications.

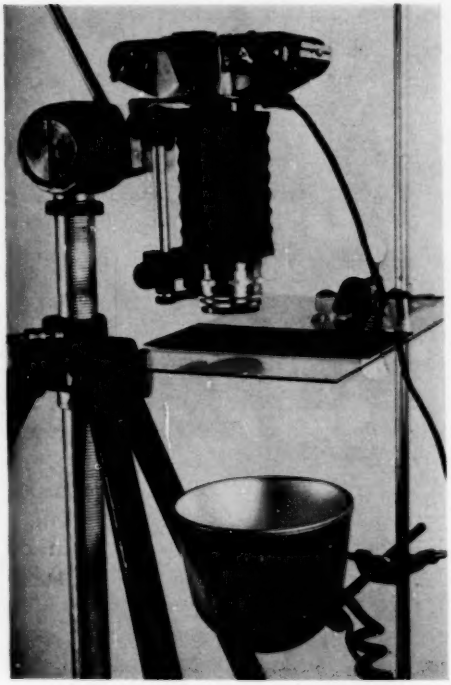

Fig. 5. Transmitted light set-up.

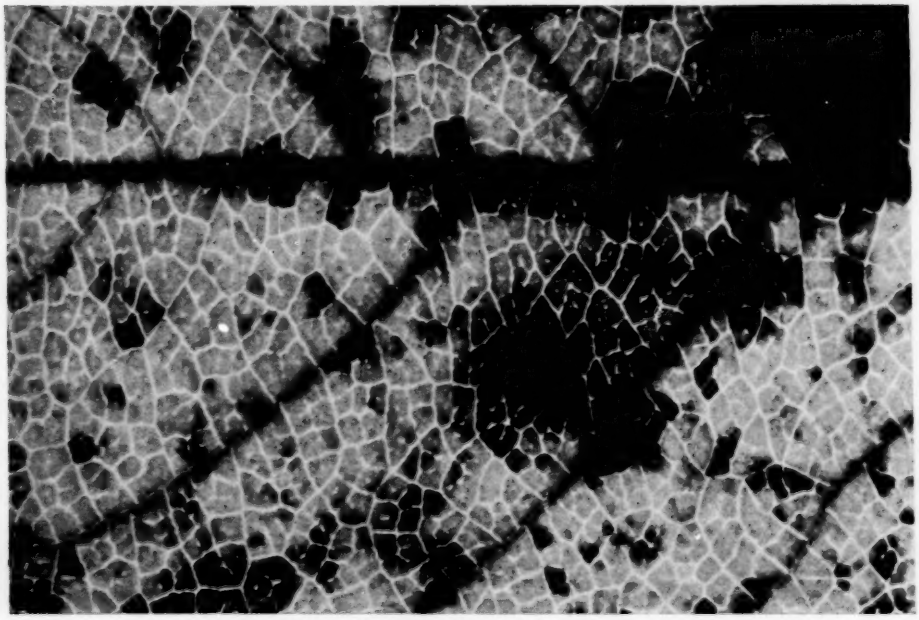

Fig. 6. Leaf section using transmitted light. Print magnification 5.5X.

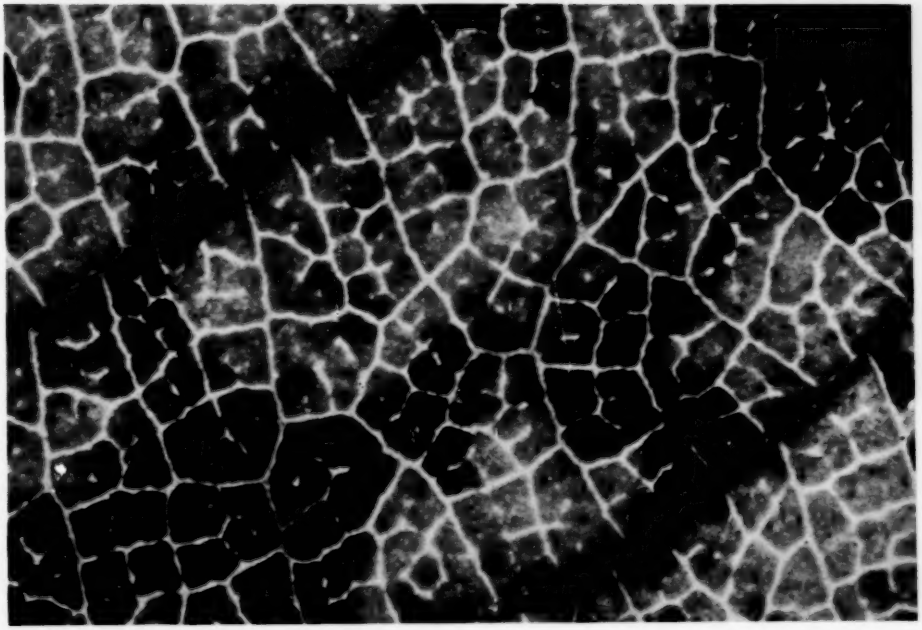

Fig. 7. Leaf section using transmitted light. Print magnification 11.5X.

Transmitted

Fig. 5 illustrates the placing of equipment for transmitted illumination of the same material as used above. Needless to say, we part company with opaque subjects at this point. The result of this technique is shown in Fig. 6, again at a magnification of 1.1:1, and showing leaf veins and infected areas. The light head is mounted, with the help of laboratory stands and clamps, ten inches below the glass support for the material. To pre-

CLOSE-UPS WITH BELLOWS EXTENSION

FOCAL LENGTH OF PICTURE-TAKING LENS ↓	1	2	3	4	5	6	7	8	9	10 ← NUMBER ENGRAVED ON TRACK	
35-MM	3 1:1,3	4 1:1	5 1,3:1	6,5 1,6:1	8 1,9:1	10 2,2:1	12 2,5:1	14 2,7:1	16 3:1	18,5 3,3:1	Exposure Factor (Multiply) Scale of Reproduction
40-MM	3 1:1,5	3,5 1:1,1	4,5 1,1:1	5,5 1,4:1	7 1,6:1	8,5 1,9:1	10 2,1:1	11,5 2,4:1	13,5 2,6:1	15 2,9:1	Exposure Factor (Multiply) Scale of Reproduction
50-MM	2,5 1:1,9	3 1:1,4	3,5 1:1,1	4,5 1,1:1	5,5 1,3:1	6,5 1,5:1	7,5 1,7:1	8,5 1,9:1	9,5 2,1:1	11 2,3:1	Exposure Factor (Multiply) Scale of Reproduction
90-MM	1,5 1:3,5	2 1:2,5	2 1:2	2,5 1:1,6	3 1:1,4	3,5 1:1,2	4 1:1	4 1,1:1	4,5 1,2:1	5 1,3:1	Exposure Factor (Multiply) Scale of Reproduction
105-MM	1,5 1:4	2 1:2,9	2 1:2,3	2,5 1:1,9	2,5 1:1,6	3 1:1,4	3,5 1:1,2	3,5 1:1,1	4 1:1	4,5 1,1:1	Exposure Factor (Multiply) Scale of Reproduction
135-MM	1,5 1:5	1,5 1:3,7	2 1:2,9	2 1:2,4	2 1:2	2,5 1:1,8	2,5 1:1,6	3 1:1,4	3 1:1,3	3,5 1:1,2	Exposure Factor (Multiply) Scale of Reproduction
150-MM	1,5 1:5,8	1,5 1:4,2	1,5 1:3,3	2 1:2,7	2 1:2,3	2 1:2	2,5 1:1,7	2,5 1:1,6	3 1:1,4	3 1:1,3	Exposure Factor (Multiply) Scale of Reproduction

TABLE I

vent flair, black paper is placed beneath the subject, with a cut-out of adequate size to accommodate the area to be photographed. Placement and focusing is accomplished with the aid of a No. 1 flood, afterwards replaced with the speedlight head for an exposure at f. 22.

Fig. 7 shows the same subject when photographed by transmitted light at a magnification of 2.3:1 with the indicator arrow on the bellows track set at the engraved 10. Exposure f.16. Although the table gives a factor of 11 for this magnification with a 50 mm lens, the setting mentioned above, rendered the best results with this material.

The three methods described above, by showing a specific condition more clearly, can sometimes greatly improve the value of scientific photographs, and make available to the scientist accurate records which illustrate the results of his research more effectively.

Acknowledgements

The author wishes to thank Mr. G. H. Parker, Head, bio-Graphic Unit, Canada Agriculture, for his valuable help in checking the manuscript. Further thanks are due to the Exakta Camera Co., New York, for allowing the reproduction of Table 1.

Dr. Buchsbaum is writing two books, one on the living invertebrates and one on ecology, both to be illustrated with color photographs, as well as black-and-white photographs. He should like to request our members to offer to him for sale excellent transparencies in color and good black-and-white prints.

He wishes them sent to the following address: Dr. Ralph Buchsbaum, Dept. of Biological Sciences, University of Pittsburgh, Pittsburgh 13, Pa.

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Photography of the Eye

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THE eye, being our only organ of vision, is extremely important to us, and fortunately is equipped with many defences to protect it against abnormal circumstances which may impair its functions or damage its delicate structures. Heat or strong light will start a chain reaction of protective measures. Blinking, contraction of the eyelids, lacrimation, rotation of the eyeball or movement of the head away from the source of irritation, against abnormal conditions. Prolonged or intense heat and light will eventually cause dryness of the cornea and may also have an unfavorable psychological effect upon the patient. These conditions may be exaggerated by ocular irritability due to drugs or disease.

The problems encountered in photographing the ocular adnexa and anterior portion of the eyeball are somewhat peculiar to photography of the eye. These problems may be minimized by special techniques. There are two main problems:

1) Photophobia
2) Corneal reflections

Photophobia is one of the chief defences of the eye mechanism. It varies a great deal among normal patients and usually varies indirectly with the amount of pigmentation. Ocular diseases and drugs which dilate the pupil (mydriatics) also increase the degree of photophobia. This natural intolerance to large amounts of light produces lacrimation, spasm of the eyelids, and head movements. Each of these reflex protective mechanisms increases the problems of ocular photography.

Corneal reflections are produced from the anterior and posterior surfaces of the cornea, which act as convex and concave mirrors respectively. These specular reflections frequently obscure the area which is photographed.

Difficulties arising from corneal reflections and photophobia are partially solved by using smaller or more distant light sources, by using faster shutter speed and shorter duration of light exposure, by immobilizing the head and by performing the entire procedure as quickly as possible. In addition to the usual problems listed above there may also be difficulties with extremely nervous patients or small children. With such cases, time must be taken to reassure the patient, and put him more at ease. With such cases, it is a good idea to take several exposures to be assured of obtaining one or two successful pictures.

Light Sources

The most common light sources used to photograph the anterior portion of the eye, in both black and white and color are the electronic flash, photoflash bulbs and photoflood lights.

In color photography, color quality and color temperature are extremely important. The electronic flash has a color temperature ranging from 6000°K. to 7000°K. Because this is approximately

equivalent to sunlight (5000°K. to 6000°K.), most daylight color films are balanced for this color temperature. The difference of the color temperature between the electronic flash and sunlight may be overcome by using a color correction filter. Because of its short duration, the electronic flash is ideal for eye photography, particularly when the patient is a child, or when his eyes are very sensitive to light. In spite of the initial cost, electronic flash is cheaper than photoflash bulbs.

Flash bulbs provide a color temperature of 3800°K. and excellent light quality for the tungsten type of color film. They can be used with the Ektachrome F: type and others similar to it without any color correction filter. The light duration is much longer than that of the electronic flash, but movement may be eliminated by using an exposure of 1/50 second or shorter. The light spectrum is well distributed and suitable for color photography. Photoflash bulbs should never be used without a plastic or glass shield, as they might explode and injure the eye. The shield or protector should be translucent and colorless so that it does not affect the color temperature.

Figure 1. Both pictures were taken with electronic flash. Eye A: photoflood was used in addition to flash. Eye B: taken in a darkened room. The englarged pupil did not have time to contract because of 1/10,000 second light duration on exposure.

Photofloods like GE No. 1 or No. 2 have good color balance and, when new, have a colour temperature of 3400°K. With use, both the color temperature and the light output decrease. The life span of the bulbs is between 4 and 5 hours. Because a rise or drop in line voltage will also affect their color temperature, the voltage should be checked to assure sufficient output. Photofloods are the least suitable light source for eye photography. The long exposure needed results in a gradually increasing intensity of heat. If photofloods are used it is advisable to install a special high-low switch, so that they can be burned at a low intensity for focusing and at high intensity for the duration of the exposure. Photofloods are often used in Operating Room Photography, but spotlights are preferable.

Protectors used with photofloods should be made of glass. Material like plastic may melt, explode or ignite under the steadily increasing heat.

Reflectors

Photoflash, photoflood and other light sources, radiate light energy equally in all direction, and their efficiency may be greatly increased by using a proper light reflector. A reflector placed behind the light source will recover much of the light which would otherwise be lost. In eye photography, because the area to be illuminated is small, only a minimum highlight is desired, the reflector used should be the size of the light source (bulb) or a little larger. Because it is difficult to find reflectors of the correct size for eye photography, many photographers make their own. This is simply done, either by cutting down the rim of

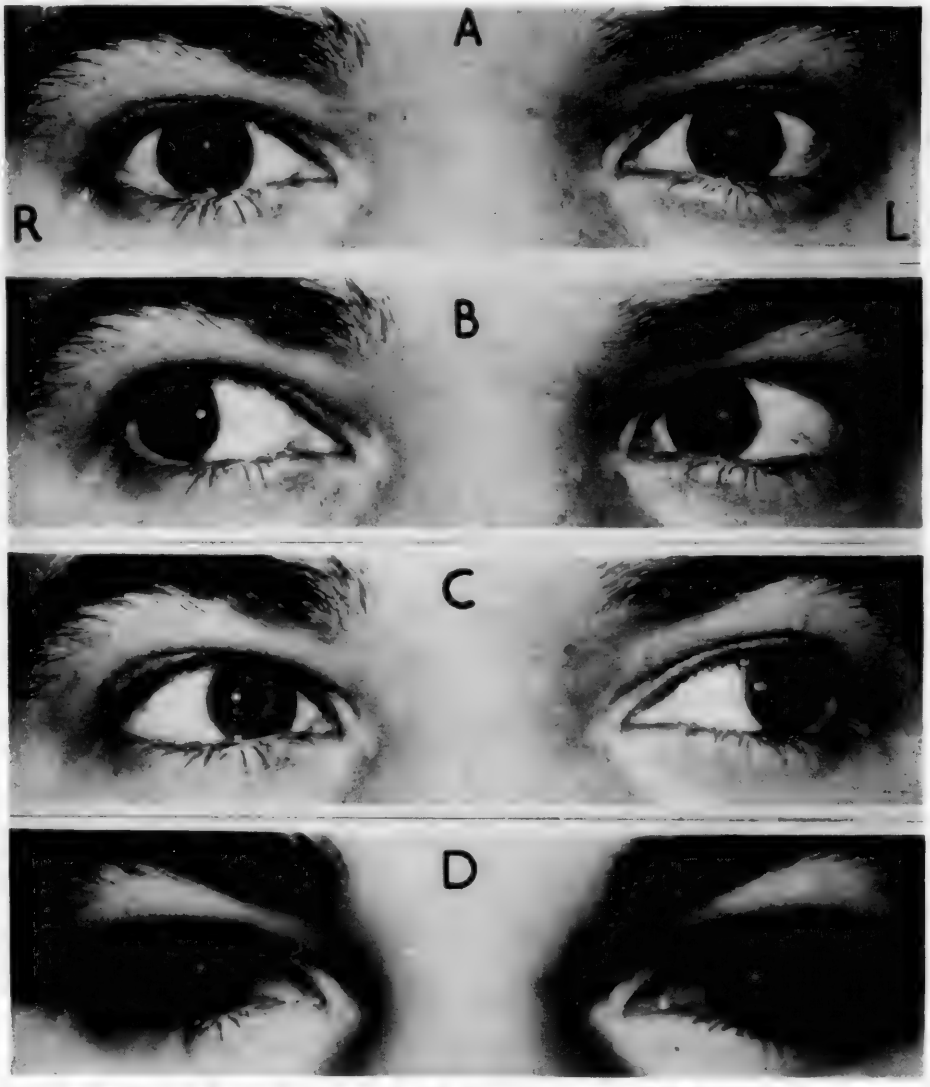

Figure 2. Eyes A, B and C were taken with one electronic flash in a brightly lighted room. Eyes D are the same eyes photographed with infra-red light and film.

an old reflector or by using various sizes of tin cans. A highly polished surface is good only if the reflector is well constructed: a slight flaw may result in a hot spot; however a slightly roughened surface gives a softer and more evenly distributed light. Reflectors must be constructed of a material which will reflect the entire color spectrum without absorbing or affecting any color. For example, a gold surface will absorb blue colors in the spectrum and thus change the initial color balance of the light source. Aluminum is an excellent material and is only

slightly affected by surface oxidation. This decreases its efficiency a little, but most manufacturers now treat the reflecting side with a special process to prevent oxidation.

Black Reflectors are reflectors with the interior surface painted black. Their function is not to reflect light but to absorb it. This minimizes corneal reflection, and prevents images of surrounding objects being reflected on the eye surface. Black reflectors are easily made by painting the edges and inside with a heat resistant flat black paint. Before the second coat of paint dries, if it is sprinkled with black wool, the resultant roughness will absorb most of the light.

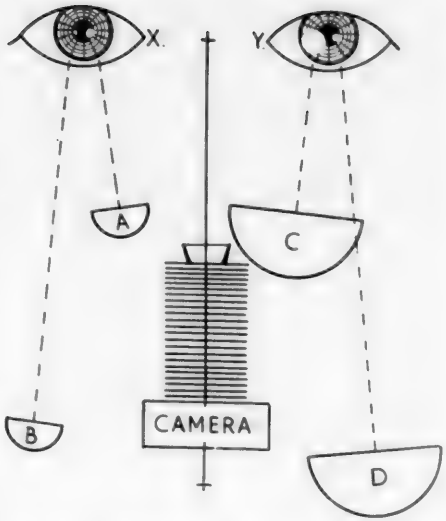

Figure 3. Reflectors A and C are equal distance from the eye, but the highlight from reflector C is much larger than that from reflector A. The lights from reflectors A and D are approximately the same.

Diffusing Screens

Diffusing screens, if used, must also be constructed of a material which will not affect the color balance. Spun glass screens are good. Tissue paper, cloth, some plastics, etc. should never be used as they may transmit color proportions unevenly and change the color balance. If they are inflammable, they may be dangerous.

Spotlights

Spotlights are light sources enclosed in housings which may vary in shape, e.g. cylindrical, cubical, etc. Usually there is a condensor type lens in front of the light source and sometimes a concave reflector mirror behind the light source. The most commonly used bulb is of the projection type. The light beam is conveniently focused by varying the distances between the light source, the lens, and the reflector.

Spotlights are preferred in motion photography, both in studio and operating room. If they are to be used over a long period of time they should have heat absorbing filters to prevent dryness of or injury to the eye. Because the condensor and filters used in spotlights are usually of a low grade glass, the color temperature may be affected. This may be remedied by taking test pictures and then adjusting the color difference by using a suitable color correction filter on the camera or in front of the reflector.

Spotlights are well suited to polarized-light photography. The light source is small in diameter and requires a small polarizing filter. The housing is so constructed that stray beams of unpolarized light do not escape. It must also be remembered that when using polarized light all other lights must be turned off.

In flash illumination, a spotlight can be used successfully if a pilot light is used for focusing. The flash light is synchronized with the camera. If two electronic flash light arrangements are used, the second flash may be synchronized by a photoelectric cell.

Fluorescent Illumination

This is the least suitable type of lighting for eye photography. The light intensity is low and the area of light source is large. Fluorescent lights are also bulky and too unwieldy to use with ease in photographing the eye.

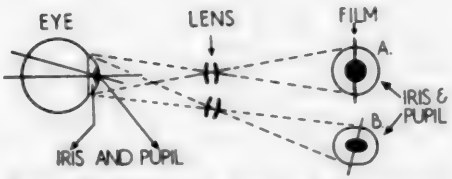

Figure 5. Distortions due to faulty camera alignment or to shifting of the eye.

Control of High Light

The cornea is round and moist and readily reflects light from its surface. There is always a possibility that the high light may obscure the area which we want to show in the photograph, and so an attempt is made to keep the corneal reflection small or even eliminated at times. It is possible to control the reflection by the size of light source and the distance from the light source to the eye. A small light close to the eye will give the same high light as a larger light farther away. The small light source is preferred; it does not have to be as powerful as a larger light source and may be placed in front of the camera and photographer, so that their images are not reflected on the cornea. Because the small light placed close to the eye is easily manipulated, the position of the high light on the eye can be easily controlled.

When electronic flash or flash bulbs are being used a modelling light should be used for modelling so that we will know exactly where the high light will be. Another advantage in using a modelling light is to determine that the light distribution over the eye is correct. Ring light illumination over the camera lens is convenient and easy to operate, but does not offer any means of combination lighting. Its drawbacks are 1) the high light is always in the center. 2) the high

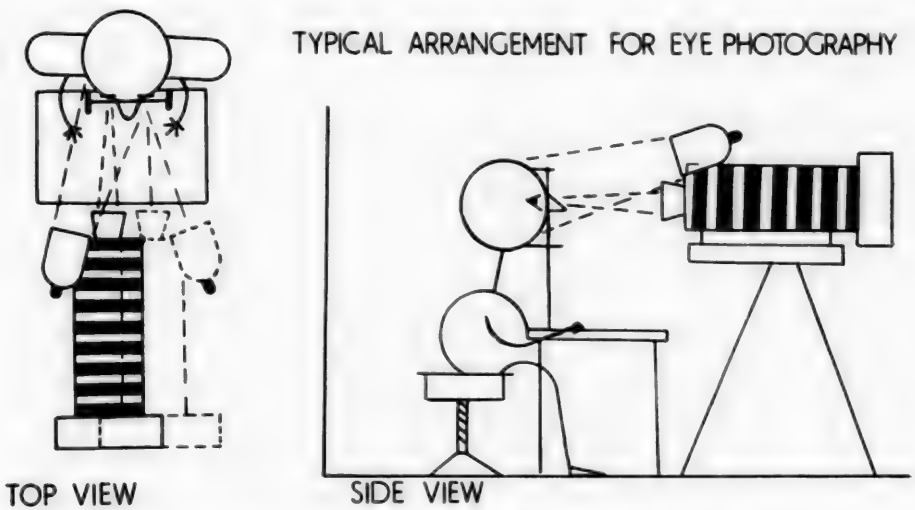

Figure 4. A typical arrangement for eye photography.

light is large because of the short distance from the light to the cornea. 3) there is always shadowless illumination, which is not desirable in all cases. If electronic flash is being used, there may be some reflection of the color from surrounding objects and resulting impairment of the color balance. This may be avoided by having the walls and other large surfaces, painted a neutral color, (grey, white, black, etc.)

Light Placement

The light or lights should be placed so that their illumination is evenly distributed over the eye and there are no shadows cast, either from the nose or the eyebrows, on the area to be photographed. If one light is to be used on photographing the right eye, the light is placed in the midline of the eye and to the left of the camera, close to the bellows extension. This placement should give a shadowless picture.

When photographing both eyes, two light sources may be used, each placed approximately 30° from the axis of the lens. The two light illumination offers greater plasticity in emphasizing surface irregularities such as texture, elevations, tumors and scars.

If only one light is used in photographing both eyes, it should be placed directly above the camera close to the lens or the bellows extension. The electronic flash light is well suited for this purpose.

Immobilization of the Patient's Head

A firm support is essential for successful eye photography. The most common method is to place the head in a special chin and head support. The support is attached to the bench in front of the patient. His chin is forward, resting on a small, shaped tray and his forehead presses against a wire or metal ribbon bar. This position is maintained by exerting light head pressure forward. This method is better than a back support and allows more room for the camera stand, especially with obese patients.

The most simple but least effective method is to merely place the patient's head against the wall.

In photographing an unco-operative patient or child, head immobilization can

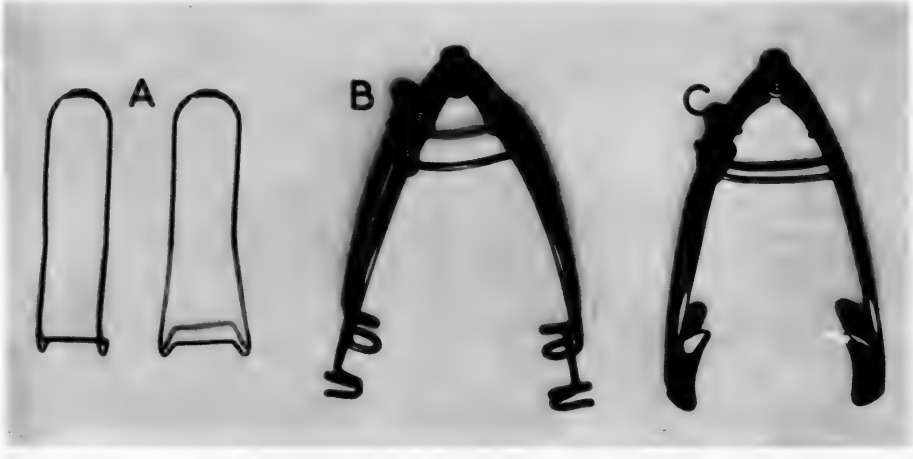

Figure 6. Different types of specula used for retraction of the eyelids.

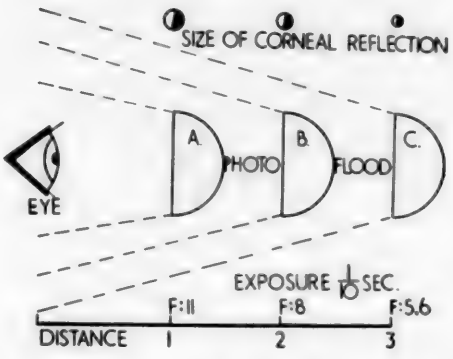

Figure 7. Control of the size of corneal reflection and the effect the various differences have upon the exposure.

be a big problem and an assistant or a nurse may be required in addition to a proper head support. With small children the assistant may have to hold the head firmly against her body to restrain movement. As we mentioned before, in cases like these, it is a good idea to take more than one photograph.

Eye Fixation

With co-operative patients, the spotlight type fixation is very good. The patient is asked to look at a small light and his eye follows it as the operator moves it to the desired position. A similar but less effective method is to ask the patient to look up or down, right or left. Eye fixation is always difficult with small children. It may be helpful to attract the child's attention immediately before exposure and obtain momentary fixation.

Eyelid Retraction

The simplest way to retract the eyelids is to have the patient hold them open with his fingers. This could also be done by an assistant. If plastic or wire retractors are necessary they are to be used after a local anesthetic has been administered and must only be handled by a doctor or a specially trained nurse.

Light Sensitive Material

With black and white film, the slower the emulsion speed, the finer the film grain, and the better its resolving power. With the finer types of illumination high film speed is not necessary. In eye photography, where a maximum definition and contrast are desired for projection of enlargement, a medium fast panchromatic film should be used, such as 12-34 A.S.A. Development should be carried out as recommended by the manufacturer of the film. Ultra fine developers reduce the film grain at the expense of the film speed. It is therefore better to use a slower speed film, which will have better definition and usually has a shorter developing time.

Most photography of the eye requires color film. The fine color changes in the eye cannot be shown adequately in black and white. The best color reproduction will be achieved by exposing the color film to the light source for which the film was made. Tungsten type film should be exposed to photoflood or flash bulbs. Daylight type color film is used with the electronic flash, which closely resembles sunlight in color temperature. Daylight type color films may be converted to tungsten type, and vice versa, by using the proper converting filters, but in doing this, some of the color quality is apt to be lost.

Different color light sources such as daylight and tungsten should never be used together.

It is generally advisable to have color films processed by a reputable developing firm, and usually a special fast service can be arranged for medical purposes. There are, however, times when it is more feasible to do one's own developing. The processing firm may be a great dis-

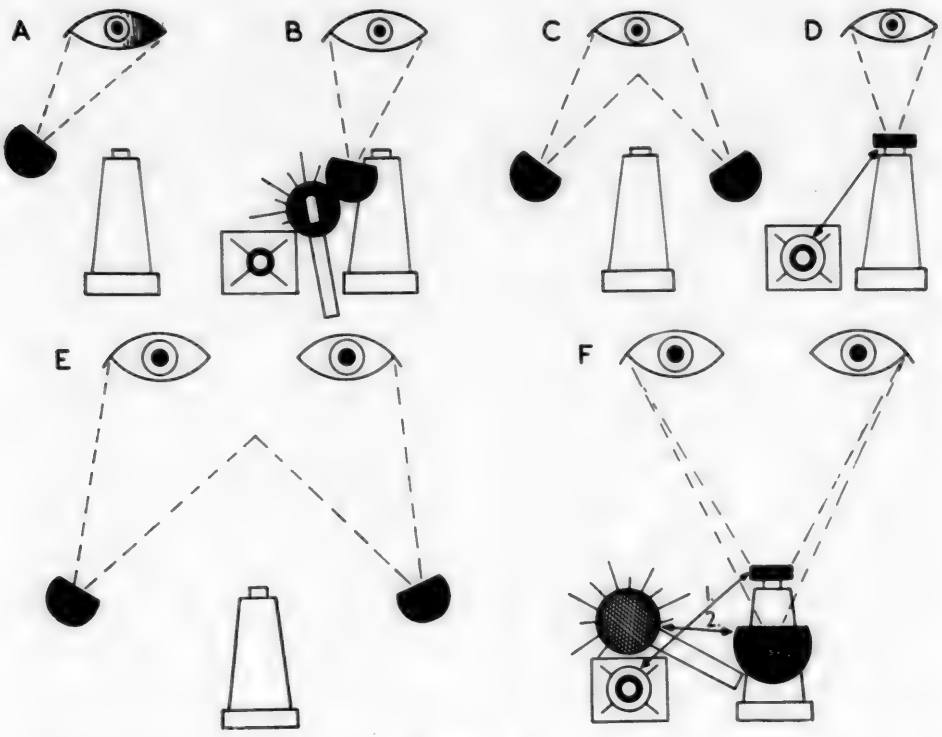

Figure 8.

A: Light placed too far to one side causes shadows.

B: Correct light placement.

C: Two light placement.

D: Ring light illumination.

E: Two light arrangement for two eye photography.

F: One light arrangement for two eye photography.
1) ring light
2) flash with reflector

tance from the studio and mail service slow; immediate developing may be needed: special technique may be required, such as increasing the film speed by forced development (this is not recommended unless absolutely necessary, as forced development lowers the film contrast and affects the color quality). Also, if six or more rolls of 20 exposures are being used each week, the cost of chemicals alone may warrant one's own developing.

Exposure

When using electronic flash or flash bulbs it is best to make test exposures in black and white, and color, at various distances and magnifications. The most satisfactory exposure is then selected and future negatives or color positives will be similar to it as long as the photographic arrangement, film, exposure, time, light source, and developing techniques are the same. This method may also be employed when other light sources are used,

such as photo-flood and reflectors. However, with light sources other than the flash, an exposure meter may be needed to determine the initial exposure. One important point to be remembered is that the effective F: value is changed when the distance between the camera and the subject is less than 8 times the focal length of the lens. The effective F: value may be calculated thus: Effective

$$\text{F: value} = \frac{\text{indicated F: value X lens to film distance}}{\text{focal length of lens}}$$

Once the correct exposure has been obtained it should remain constant and will be routine from day to day.

Cameras

The camera used in eye photography should have ground glass focusing. It should have a double bellows extension or a means of adapting extension tubes, so that an image-object ratio of 1:1 may be attained. The ideal negative size is 35mm. This will allow the entire negative to be covered by one eye and eliminate waste of film. If a larger negative is used and only one eye is photographed, the surrounding and out of focus area should be masked out.

A between-lens shutter is most suitable when an electronic flash or flash bulb is used, because it can be easily synchronized at any shutter speed. A focal plane shutter can also be used at a slow shutter speed with flash illumination. High speed lenses (such as F:1.5) are not designed for short working distances. Lenses of smaller aperture are better for close up photography.

The most frequently used focal length of lens for 35mm. size film are 50mm., 90mm. and 135mm. The 90mm. is a happy medium, and gives nice perspective and good magnification.

Lenses with a pre-set diaphragm have been found to be very convenient. The focusing is made while the lens is wide open and the diaphragm is automatically stopped down at the previously selected F: number. When focusing at close distances (i.e. ratio 1:1) it is preferable to move the entire camera to bring the image into sharp focus on the ground glass.

Figure 9. A: Back support. B: Chin and head support.

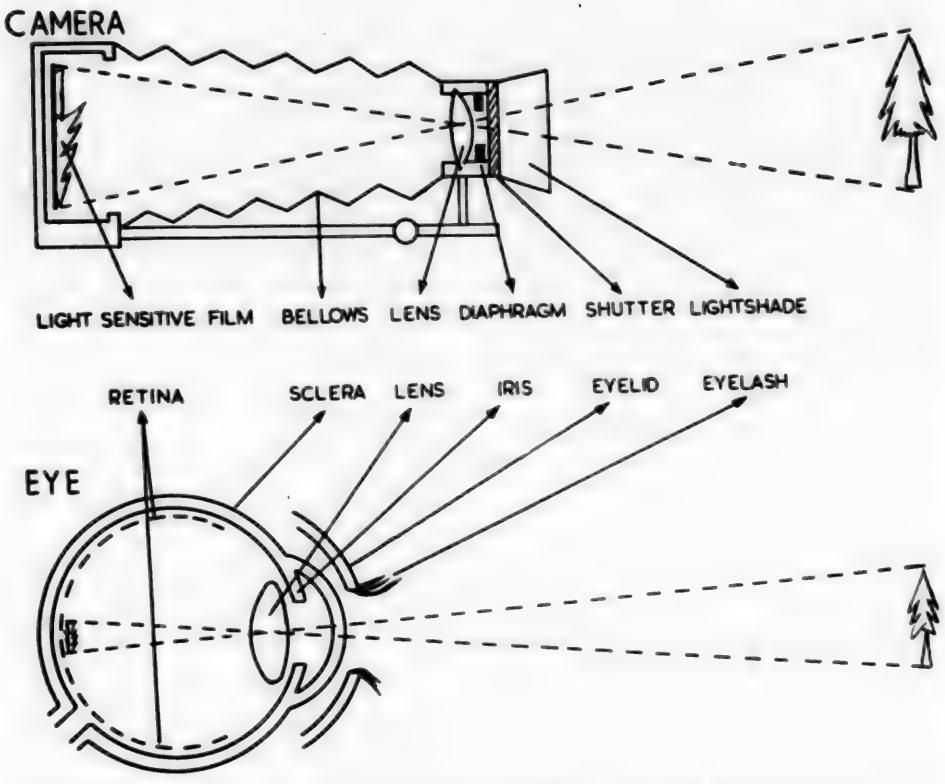

Figure 10. Diagramatic drawing showing how the different parts of the camera have corresponding parts in the eye.

Eye Photography in the Operating Room

The same precautionary rules for general photography in the Operating Room apply for Eye Photography in the Operating Room. In many ways the photography is greatly simplified.

A) The patient is lying in a prone position on the Operating Table.

B) The head is positioned so that neither a head nor a chin support is necessary.

C) Fixation of the Eye is unnecessary because the anaesthetic has rendered the eye immobile and insensitive to light.

D) The eye is well exposed.

Position of the Camera and the Photographer

1) All arrangements should be complete before the operation begins so as not to interfere with the routine of the operation. Any final arrangement due to a slight change in position of the patient's head, can be made during the operation.

2) The camera should be placed above the patient, more than twenty inches from the eye, to avoid any interference with the surgeon's head.

3) A special tripod, well counter-bal-

anced to prevent tipping, may be used. The horizontal bar projecting over the patient's head, supports the camera. Another arrangement consists of building a special scaffold of wood or aluminum, over the operating table. This supports the photographer, who lies on top. This removes the photographer from any possibility of interfering with the operation, and at the same time allows him greater ease in controlling his equipment. This arrangement is particularly well advised for taking motion pictures and when using different focal length lenses. When photographing the whole operation procedure, a roll film (35mm) camera is recommended because of the speed at which the sequence of pictures can be taken.

4) Any part of the equipment likely to be touched by the surgeon's person during the operation should be wrapped in sterile sheets to prevent contamination.

Light Sources

1) An electronic flash in a small reflector is very well adapted for photographing the eye in the operating room. Caution must be taken because of the immediate dangers if combustible anaesthetics are used. Most eye operations are performed under a local anaesthetic or heavy sedation. These conditions remove any danger of explosion.

   Special electronic flash units suitable for use in potentially explosive atmospheres are available, in spite of the high initial cost. This insures the safety of the hospital and the patient.

2) Ring light illumination for eye photography is not well suited because of shadowless light and low contrast. It produces a flat quality in the pho-

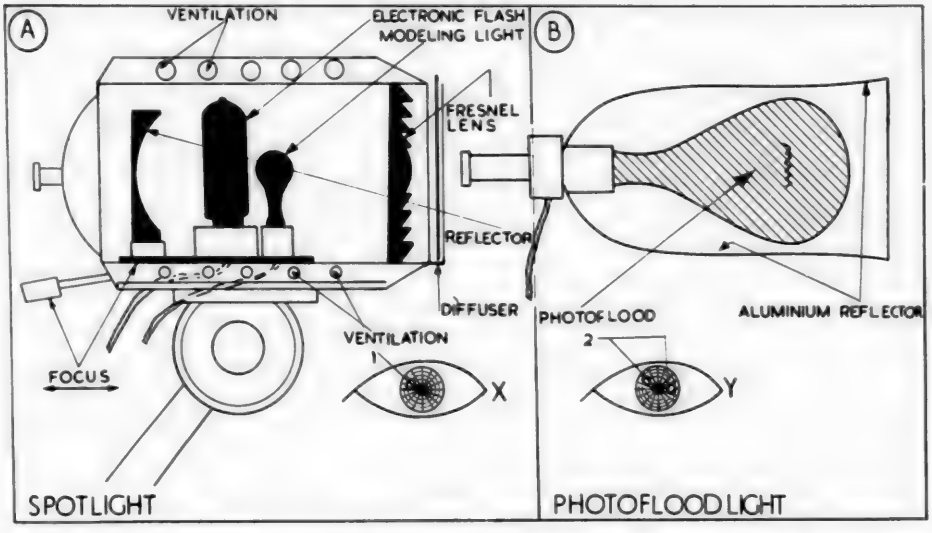

Figure 11. A: Sketch showing the possible construction of a spotlight having a modelling light and an electronic flash. B: Simple photo-flood light with an aluminum reflector of small diameter to minimize, highlight reflection in the eye.

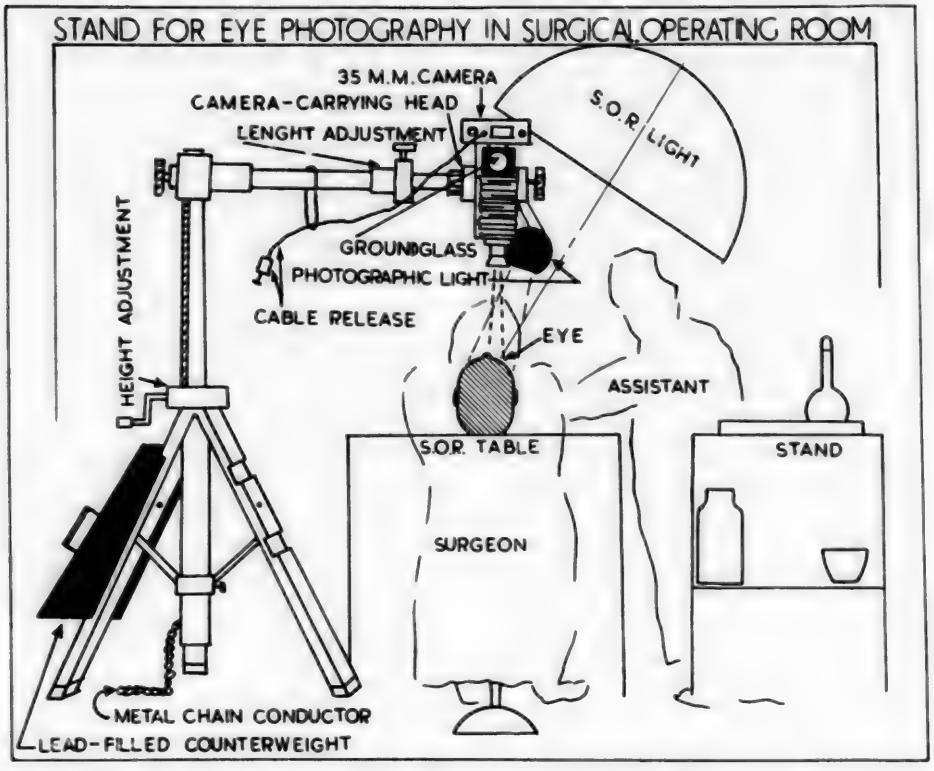

Figure 12. A specially designed tripod with horizontal bar, which can be very conveniently used in a minimum of space.

tograph. In good eye photography, shadows should not obscure any area but should build up sufficient contrast to produce a realistic photograph.

Flash Bulbs

Because of their tendency to crack or explode, flash bulbs should never be used in the presence of combustible anaesthetics. They may be used when the patient is under a local anaesthetic. Under any circumstances they should always be enclosed in a protective shield.

Photo-Floods

Photo-floods may be conveniently used if they are specially constructed to be explosion proof.

For still photographs, the subject should be illuminated only for the duration of the exposure.

The surgeon should be informed of any projected pictures. Learn to communicate by code, to prevent his being made nervous by an unexpected noise at a delicate moment in the operation.

When using photo-floods for motion photography, they should preferably have cooling system and heat absorbing filters to minimize the drying of the cornea.

Available Light

The light used in the Operating Room could be used to take black and white

photographs. Color photographs may require a color correction filter. The exposure would be rather lengthy (1/25-1 sec.) depending on the film speed and the lens aperture used. To prevent any loss of sharpness due to movement of the camera, a steady camera support will be required. However, this lighting is not recommended. Better results are obtainable by the methods previously outlined.

Light Placement

The lights should be so placed as not to interfere with the surgeon's head. If photo-floods are being used, care must be taken,

1) not to allow light to shine in the surgeon's eyes.
2) not to cause him any discomfort from unnecessary heat.

General Precaution

The camera parts, lens shade, filter, cable realease, etc., must be secured to prevent their falling in the operative field.

Photography of the Fundus Oculi

The photography inside of the living eye is made possible by means of a special camera designed for this purpose. The Zeiss-Nordenson Retinal camera has been available since 1920. The Bausch & Lomb Retinal camera has been manufactured in the U.S.A. since 1951. Both of these cameras are comparable in oper-

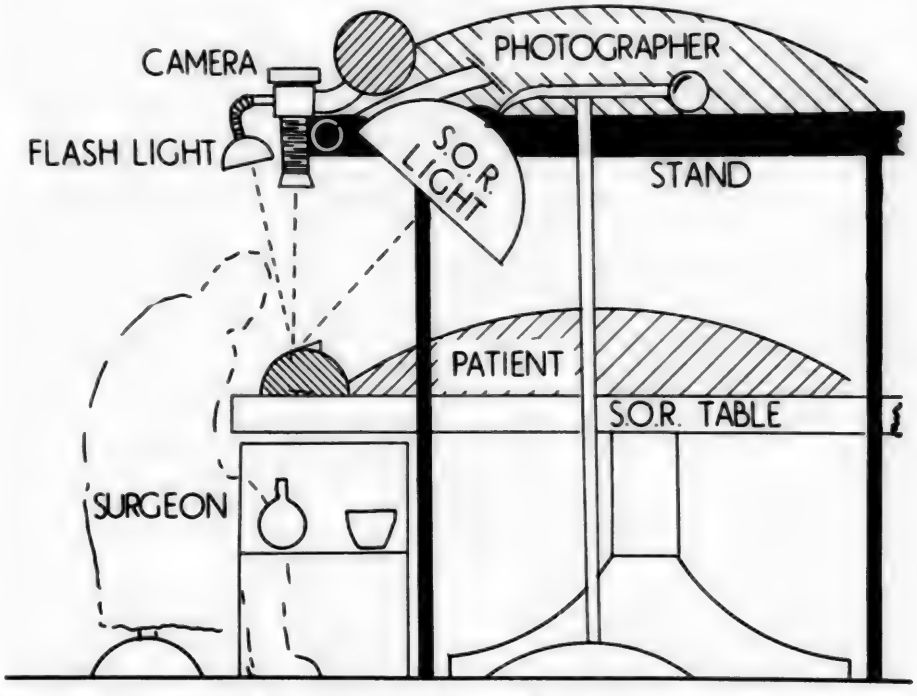

Figure 13. An alternative arrangement for camera and photographer, its main feature being:
a) The ease with which the photographer controls his equipment.
b) The fact that he is removed from interfering with the operation.

ation and photographic result. Both black and white and color photographs can be easily taken after the operator is familiar with the apparatus and its operation. Since this time over five new Retinal cameras have appeared on the market.

Short Description of the Bausch and Lomb Retinal Camera

The retinal camera combines a large monocular ophtalmoscope, a high intensity carbon light illumination and a camera system. A small fixation light is attached on a movable arm for the patient's eye fixation. This unit is supported by a specially designed base with horizontal, vertical and angular movements, which are easily operated and conveniently located for smooth operation. Because of the fact that the camera is a reflex type, the image is seen up to the time of the exposure.

The camera body is a standard Kodak Bantam which takes normal 828 film of 8 exposure rolls in black and white or color. Different camera bodies can easily be interchanged when using different films. A special dark slide protects the film when the camera is removed. Different exposure times can be selected depending on the film used. The shutter mechanism is fully synchronized with the reflex mirror and operates by pressing a single cable release.

Photography of the Fundus

The room where the procedure is taking place should be dimly illuminated so

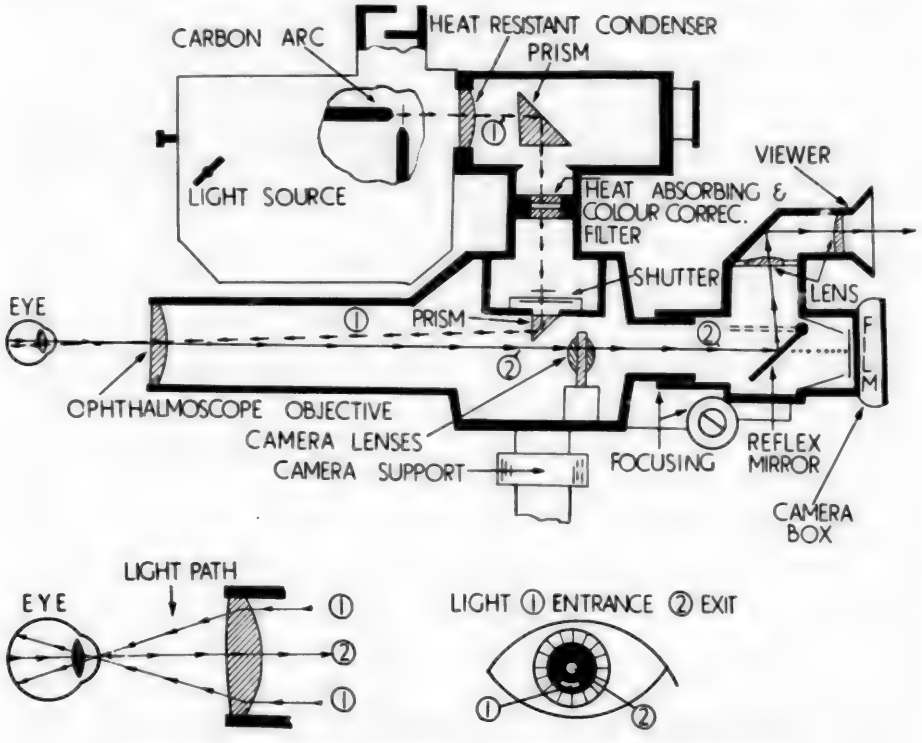

Figure 14. Diagramatic drawing of Bausch & Lomb Retinal camera.

that the fixation light is visible. The camera should be checked before hand and all adjustments made—then the chair adjusted to the patient's height and the chin-forehead support adjusted; camera loaded with correct film, carbon arc lights adjusted, clockwinding mechanism checked so that the light source is constant and of high intensity. Paper, pad and pencil should be conveniently placed so that each exposure can be recorded for later identification. The patient must be prepared before the photographs of the fundus can be taken. The pupil must be dilated to a minimum size of 7mm. for best results.

The retinal camera is placed at the proper height and in the proper position. The distance from the patient's eyes to the ophthalmoscope lens for the initial start should be about 3-4 inches. The dilation of the pupil by mydriatics should only be done by a physician or a specially trained nurse.

Before the photographing of the fundus, it is a good idea for the physician to show the photographer the exact location to be photographed. This preliminary examination can be easily done by a standard ophthalmoscope. A mental note should be made by the photographer as to the position of the lesion so that when the patient is ready for the fundus photography, a minimum of time is lost in finding the exact position. The patient should be put at ease and given an explanation of what to expect. The patient can be reassured that the light is not harmful to the eye. Sometimes the placing of the hand before the light beam can convince him that the light is not hot. The patient is asked to relax, to sit straight, to make himself comfortable, and to fix his eyes on the small fixation light. For smooth operation, there is no substitute for experience. Stereoscopic pictures can be taken with co-operative patients by special techniques like displacing the eye by means of a fixation light (taking two pictures from two angles comparable to the normal human visual interocular distances at different previously calculated positions).

Color is essential in most cases when photographing the human ocular fundus. Because of the delicate changes in color condition which cannot be appreciated when using black and white film. In addition, color gives a more realistic plastic appearance and better perception of depth.

The duration of an exposure in an average subject with the pupil well dilated and illuminated using film speed of 12 A.S.A. will range between 1/10 and 1/25 seconds.

The portion of the eye most frequently photographed is the posterior part including the optic and macular region. In some cases where there is excessive elevation or depression of the retina, the depth of field will not permit having the whole area in focus. In those instances two photographs should be made at different planes of interest.

Most common causes of unsatisfactory fundus photography are due to:

a) Blinking.

b) Eye movements.

c) Inadequate dilation of the pupil.

d) Cloudy or scarred media of the eye.

e) Improper position of carbon.

f) Not sharp focussing.

g) Use of incorrect film.

h) Faulty film processing.

i) Lack of familiarity of fundus camera.

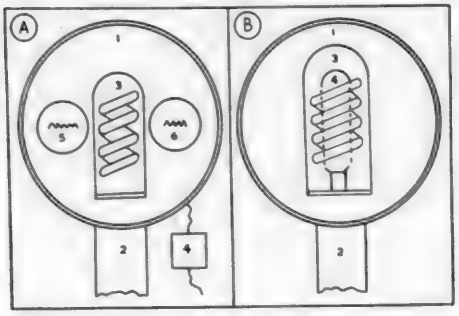

Figure 15. Electronic flash with modelling light.

Slit Lamp Photography of the Eye

The slit lamp is the instrument used by the ophthalmologist to examine the anterior portion of the eye. This examination of the eye, also referred to as biomicroscopy, provides a microscopic examination of the cornea, anterior chamber, iris, lens, and the anterior third of the vitreous. These portions constitute the anterior segment of the eye.

The apparatus used in this technique consists of two main portions: the illuminating arm which provides illumination in the form of a slit, and a microscope. The "slit" is a narrow beam of conveniently focused light directed obliquely at the part of the eye to be examined. Observations are made by means of a low power binocular microscope focused on the illuminated area.

In taking the slit lamp photographs, the main problem is to obtain adequate illumination. By substituting the microscope for the reflex camera, and using existing illumination, color photographs can be made at low magnifications using rather slow shutter speeds from 1/15-1 sec. To get best results with such a long exposure, an extremely co-operative patient is essential. Otherwise the image will be blurry due to eye movement.

To photograph the angle of the anterior chamber a special unit known as a gonioscope is used which does not necessarily need slit illumination.

Conclusion

The uses of eye photography are many and varied. It is becoming increasingly important to teaching, research, publication, legal procedure, disease and follow up and recording of operative procedure.

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Some Recent Advances in Microscopy, III. Photomicrography

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PHOTOMICROGRAPHY has been active during the five years since the previous review.[59] Motion pictures and apparatus are brought together in Michaelis' monograph.[51] The Eastman Kodak Company has published a small booklet,[2] Michel[52a] and Pizon[57] books on photomicrography and Kuhl[38] on cinephotomicrography of tissue cultures. Dragesco has written several chapters on photomicrography[71] and Linssen[44] on stereophotomicrography.

Dragesco[20] comments on the technics used for cinephotomicrography in Great Britain, and Richards[62] on methods in terms of the information derivable from the photomicrographs. Technics for phase microscopy are available,[58,60] Manigault[47] considers punched card methods for cataloging photographs and there is a recent panel discussion of the Biological Photographic Association.[4]

Apparatus

Benford and Butterfield[5,11] describe a new series of Ultraplane eyepieces for larger and flatter fields than previous negative amplifying oculars. Michel[52] describes a camera with a cube beam-splitter that fits on the top of the microscope, and also his large, complete table unit.[53] The one-minute Land-Polaroid method of photography has been applied to the microscope by Keller[33] using a Leitz beam-splitter and stand; by Maresh and Cramer[48] with the camera mounted on an enlarger; and by Wied[74] with a Linhof Technica Camera and a Micro-Ibso beam-splitter.

Instructions for making a universal optical bench from a geodesic slide are given by Moss,[55] and Kessel and Crisp[34] describe an apparatus based on a large Bausch and Lomb photomicrographic microscope with horizontal and vertical stages, a long bellows and revolving back. Zapf[77] discusses a large unit which can be lowered into the table when not in use and which includes an incubator and other accessories. Goodwin and Avers[25] use a Shopsmith base for mounting the microscope, zirconium arc source, Micro-Ibso and Leica camera which are used for making serial pictures showing the growth and the dividing cells in roots. Dolman[18] has constructed a simple photomicrographic camera out of a box with a spring back on one side, which fits over the draw tube of the microscope.

Wang and Dooman[72] built a low power photomicrographic camera from the focussing mechanism of the microscope and the objective lens from a 2 x 2 projector. For low power work, Amies[1] recommends removing the microscope condensor and using an objective in its place. The specimen is viewed successively through two objectives which erect

the picture, or an objective is mounted within the microscope on an adjustable draw tube. The arrangement is recommended as being convenient and giving good depth of field for photomicrographs.

Flexible focussing of a Greenough microscope is accomplished by Cambar[12,13] with a motor drive and his system could be used for photomicrography. Stevenson[68] describes a combined mechanical stage and focussing control for photomicrography with a joy stick control, which was designed to study the detergent action on sigle texture fibres immersed in a liquid on a horizontal microscope.

Methods, Applications

Means suggested for indicating magnification include the use of a haemacytometer by Tomasch,[70] Johnstone's[31] showing the exact magnification with a micrometer scale placed on the positive by double printing and Richards[62a] making the scale on the negative by double exposure. The problem of locating the region where a photomicrograph is to be made, is solved by Meiller,[50] by using a preliminary print on photostat paper marked to indicate the exact area to be photographed. Solarization is used by Soares and DosSantos[66] to enhance details in photomicrographs of chromosomes from exposing the plate to light near the end of the development period. They also recommend bas-reliefs made by printing from the combined negative and positive to bring out the structure of chromosomes.

Wilkinson et al[75] solve the registration problem for autoradiograms by means of an image of a grid made on the negative and orienting the combined pictures with respect to the grid. A method for making red blood cell counts by photomicrography is described by Brown,[8] who makes the pictures on 35mm film and counts them later with the aid of a microfilm reader. Photomicroscopy of the nail bed capillary systems of psychiatric patients is a diagnostic aid.[19]

Stroboscopic photomicrography is used by Wingo and Browning[76] to measure the swimming speed of small protozoa. A rotating sector light control was used for making the successive exposures.

Illuminating and Exposure

Since photomicrography is essentially projection microscopy with photographic recording, much of the information, measurements, formulae, and calculations of Ockenden[56] can be utilized. A simple flash technic has been described by Bevis and Hetrick[6] using Köhler illumination from a Spencer lamp and then after focussing replace the lamp with a midget SM or a #5 flash bulb for making the exposure by flash. Direct current, or a low voltage source should be used, rather than alternating current, with flash bulbs. The advantages of the Zirconium arc for photomicrography are discussed by Weber.[73] Knowles[35] proposes a system, illustrated with a nomogram, whereby the luminance measured with an ordinary brightness meter can be used to calculate proper exposure. A simple exposure meter for photomicrography with a photocell and a bridge circuit, described by Clemens and Brar,[15] should be easy to build. Lonert[46] has described a flash unit based on the Heiland Strobonar I and an auxiliary lens and light for focussing the microscope preparatory to taking a flash picture. Another method for using electronic flash proposed by Carpendale and Baldes[14] is essentially a surface-type illuminator with a tungsten bulb and flash tube mounted in a small housing. Fjeld[23] brings the accessory focussing source in-

to the illuminating beam of the microscope by means of a glass plate reflector. Köhler illumination and nomograms are used to estimate the exposure. A xenon arc which can be run continuously and then pulsed for rapid electronic flash is described by Beeson and Webb.[3] Hunt[29] has proposed a simple means for keeping the luminance of a lamp constant without special equipment.

The use of color filters for obtaining contrast in photomicrography is of common usage. Locquin[45] recommends using more complex color filters which may have three or more absorbing bands. Such filters, made similar to interference filters, he proposes to call polychromatic filters and points out that certain ones are especially good for Giemsa and other multicolor stains.

Recommendations for viewing color transparencies by Sorem and Nelson[67] are an optimum luminance of about 400 foot-lamberts and that the illuminator should have the relative chromaticity distribution of a complete radiator at 4000° K. Best results will be obtained when the chromaticity of the light in the room, where the illuminator is used, is about the same as that of the illuminator. They further state that the same spectral and chromaticity requirements apply to illuminance for viewing reflection color prints.

Stereophotomicrography

Morrison[54] discusses the advantages of stereophotomicrography, a chapter is included in Linssen's book[44] and Hill[28] describes the mathematical and experimental foundations for stereoscopic photography. Brown and Robins[9,10] have modified a Greenough biobjective stereoscopic microscope to include a built-in flash source and stereoscopic camera (35mm), and Fischer[22] has a patent for obtaining three-dimensional "microphotographs" by means of a semicircular, rotating, opaque disc above the objective of the microscope, apparently using the half-aperture method. An ingenious arrangement of a rotary changer for the eyepieces and camera is attached to a biobjective microscope by Darby[17] and used for 35mm color or black and white photomicrographs.

A difficulty in using many of the 35mm stereo cameras for photomicrography arises in that the oculars of the microscope often diverge, while the axes of the camera lenses are usually parallel. Lester and Richards [42,43] solve this problem by using ophthalmic prisms with both monobjective and biobjective microscopes for stereophotomicrography. The advantages of stereoscopic photomicrography for the study of small foraminifera are shown by Evitt[21]. Stereoscopic methods have been used by Richards[61] to reveal surface structure of epithelial cells.

Hegre[26,27] photographs the top of the paraffin block containing a specimen as each section is cut with a microtome, and uses the photographs in reconstructing the original embryo; a sort of geometrical motion picture.

Cinephotomicrography

Early motion picture methods are summarized by Kuhl[38] and more recently Michaelis[51] has provided a detailed summary and analysis of motion picture methods, primarily as applied in the biological science. Elementary equipment is described by Salmon.[64]

Block and Nordstrom[7] have devised a camera stand for use with a microscope to record blood circulation of transilluminated organs. LaRue[41] describes a basic optical bench type assembly with a beam-splitter. Stockinger[69] describes equipment for use with tissue cultures, with an incubator for maintaining tem-

perature of the microscope. A fairly large unit for tissue culture applications is discussed by Sano, Gault and Henny.[65] Matt[49] uses a synchronous motor drive for time-lapse photomicrography and Koster[37] shows a time-lapse cinephotomicrographic apparatus for pictures at one cycle per second to one in nine minutes, with a Zirconium arc and timing controlled with a perforated belt driven by a synchronous motor. Jones and Fields[32] describe an inexpensive timing device which uses a synchronous motor and disc with levers to trip microswitches. A larger well designed vibration proof mounting with two Askania Cameras is described by Kuhl,[40] who also discusses[39] the analysis of films and a device for exact alignment of single frames. Motion picture equipment used with the phase microscope is discussed by Cliffe,[16] Frederic[24] and Robineaux[63]. Jarrett[30] provides exposure factors for the Cooke, Troughton & Simms phase microscopes.

An example of endoscopic cinephotomicrography is Kobrak's film of the human ear drum.[36] Other applications for use with endoscopic instruments have been described.

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Journal of the Biological Photographic Association Vol. 26, No. 1 February, 1958

Analysis of Cinema Films in Diagnosis and Research

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Aided by a grant from the National Foundation for Infantile Paralysis, and by the United Cerebral Palsy Research and Educational Foundation, Inc.

THERE is abundant literature describing studies in human physiology utilizing motion pictures. Soon after the advent of successful motion pictures in 1895, J. McIntyre, a Glasgow physician, was able to show animated x-ray views of a frog's leg. The need for an accurate method of defining the activity observed was soon apparent. Two examples of early methods used in analyzing the swallowing action illustrate attempts at accurate definition: In 1905 Eykman[1] utilized cinema study to describe more accurately the swaflowing act. The radiographic exposure was initiated by a mechanical trigger activated by the larynx as it was raised during swallowing. Motion pictures were taken of images on the fluoroscopic screen. As a final step, anatomical sketches of selected frames were drawn to obtain a more complete impression. In 1912 Kraus[2] described a technique of placing a series of single x-ray exposures of the same swallowing action one above the other to obtain a composite picture. These observations he supplemented by fluoroscopy to describe the entire process.

Although numerous studies utilizing motion pictures have been reported, detailed descriptions of methods used in analyzing these films were not usually given. A common method of cinema analysis seems to be observation of repeatedly projected films. Weinberg, Watson, and Ramsey[3] point out that observation of films at normal projection speeds is insufficient. They feel that cinefluorographic films should be viewed both in slow motion and as projection of single frames and indicate that in some respects motion study could be termed qualitative, and single frame observation quantitative. These writers suggest that the two methods supplement each other and are at their best when used in conjunction. This combination of methods of single frame projection, as well as motion projection, has been used by many writers. Others have indicated that, to obtain adequate information for cinema, additional procedures must be employed.

Moretzsohn de Castro[4] commented that, even though a cinefluorographic study has been observed in slow motion and single frame projection, it still continues to be a subjective observation of form, according to the number of observers present. He, therefore, used a technique called "roentgenological chronocinegraphy," which he defined as the

"roentgenological documentation of the movement of an organ in relation to time." In this procedure, images were projected and traced upon graphic paper. A technique of projection and tracing was also employed by Bloomer[5] and by Harrington[6] for analysis of cinema studies of palatopharyngeal movements. Harrington related his cinematography with standard lateral x-rays. Calnan[7] also used lateral soft tissue x-ray films to supplement the findings of direct vision and cineradiography. In cinefluorographic study of the lungs of cats during coughing, Franklin and Janker[8] employed a more complete method of analysis. They first projected the film repeatedly until all of the salient points has been noted. Then, from a selected portion of the film of one cat, individual frames were projected to paper and outline drawings were made. Finally a "combined drawing" was made upon a single sheet of bristol board.

In devising the method of cinema analysis here described, the following criteria were considered:*

1. More than one procedure of analysis should be employed.
2. The accuracy of each procedure should be verifiable.
3. Provision should be made to study the structures by motion projection and by the tracing of single frames.
4. Maximal clarity of image with minimal distortion should be achieved when observing the projected images and while making tracings.

In earlier analyses of cinema[9] a film editor and a 16-mm. projector were employed to provide motion effect, and a microfilm reader was used to make frame-by-frame tracings of the structures under study. The film editor was used to mark a reference at the beginning of each sequence to be studied and to gain a general impression of motions in each performance. Ease of film changing made utilization of this machine convenient for comparison of the gross structural movements seen on the films of different subjects. Because of the low light intensity and the small viewing screen, however, smaller details were difficult to perceive.

The films were further observed upon a projection machine capable of moving the film forward or backward at choice of speeds, or of stopping on a selected frame. In slow motion viewing or complete stoppage, however, the light intensity of the projector was appreciably reduced by the heat-absorbing filter which was automatically interposed in the projection path. For further evaluation the film was placed on the microfilm reader, which reflected an enlarged image to a ground glass plate where it could be viewed or traced. The film could be moved forward or backward, but there was no motion effect. The total width of the film was projected; thus, with edges of the film near the sprocket markings notched by the film editor along holes could be used as reference points. Since it was impossible to alternate from one device to the other readily, a single device was felt to be necessary.

Recently, two revised models of the Kodak "Kodascope Analyst II Projector" have been developed. These machines, specified as the "Weinberg-Watson Projector Modification," manufactured by the Genesee Tool and Die Company, Inc., Rochester, New York, and the

*The methods discussed in this paper were evolved in relation to a study of the maturation and function of the structures concerned with speech and deglutition, in the Department of Pediatrics, University of Utah College of Medicine.

"L-W Industrialist," manufactured by the L-W Photo Products Company, Los Angeles, California, make use of a remote control for reversing the film and for single frame changing. In addition, the L-W Industrialist remote control has separate switches for turning the projector on and off, for varying the projection rate from single frame to motion, and for varying the rate of motion projection from approximately 5 to 24 frames per second. These latter controls are present on the Weinberg-Watson adaptation but not as a part of the remote control.

These machines were both found suitable for use in a tracing cabinet in which the images are projected to a front surface mirror and reflected to a plate of glass (Figure 1). The images are visible when tracing paper is placed upon the glass, thus eliminating the need for a translucent glass on which to discern the images. By this means light intensity and details are maintained with minimal distortion. In addition to focus of the projector, two adjustments are critical: the angle of the mirror and the angle of the cabinet viewing-drawing surface. Raising the lid provides easy access to the mirror for cleaning. The cabinet is mounted on large rubber casters so that it can be moved easily without disturbing the alignment of the projector or mirror. Distortion and magnification of the image is identified and evaluated through the use of cinefluorographic frames of a wire grid spaced at one centimeter intervals.

A routine method for the use of a modified projector and this cabinet has been developed. The number of line tracings made of each sequence of activity depends upon changes of the position of the structures and upon the number of frames necessary to complete an activity.* Each structure may be traced in a separate color to facilitate interpretation. After individual line tracings are completed, each sequence should be incorporated into an overlay drawing (Figure 2). When using the tracing

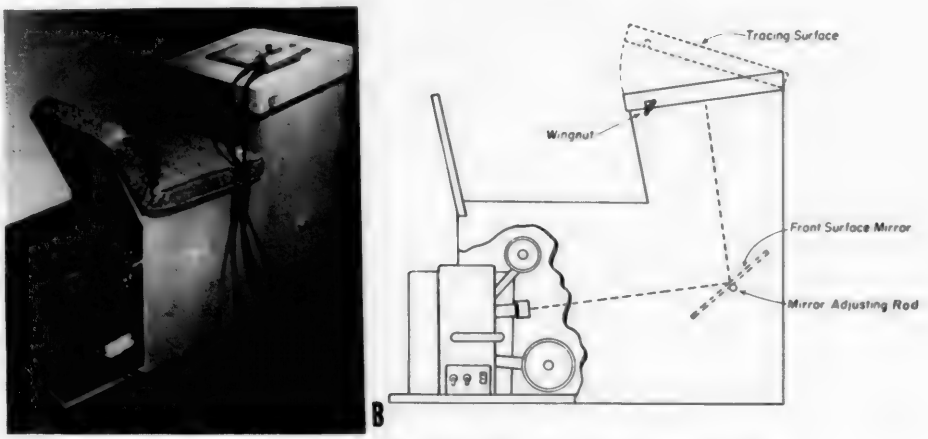

Fig. 1. Tracing cabinet. Photograph and schematic drawing.

* Various brands of tracing paper were tried to find one which permitted a clear image for tracing without adding "graininess". The tracing paper used in these studies was No. 55 Tracing Paper (type 3, class 1) manufactured by the American Blueprint Company, Inc., New York City.

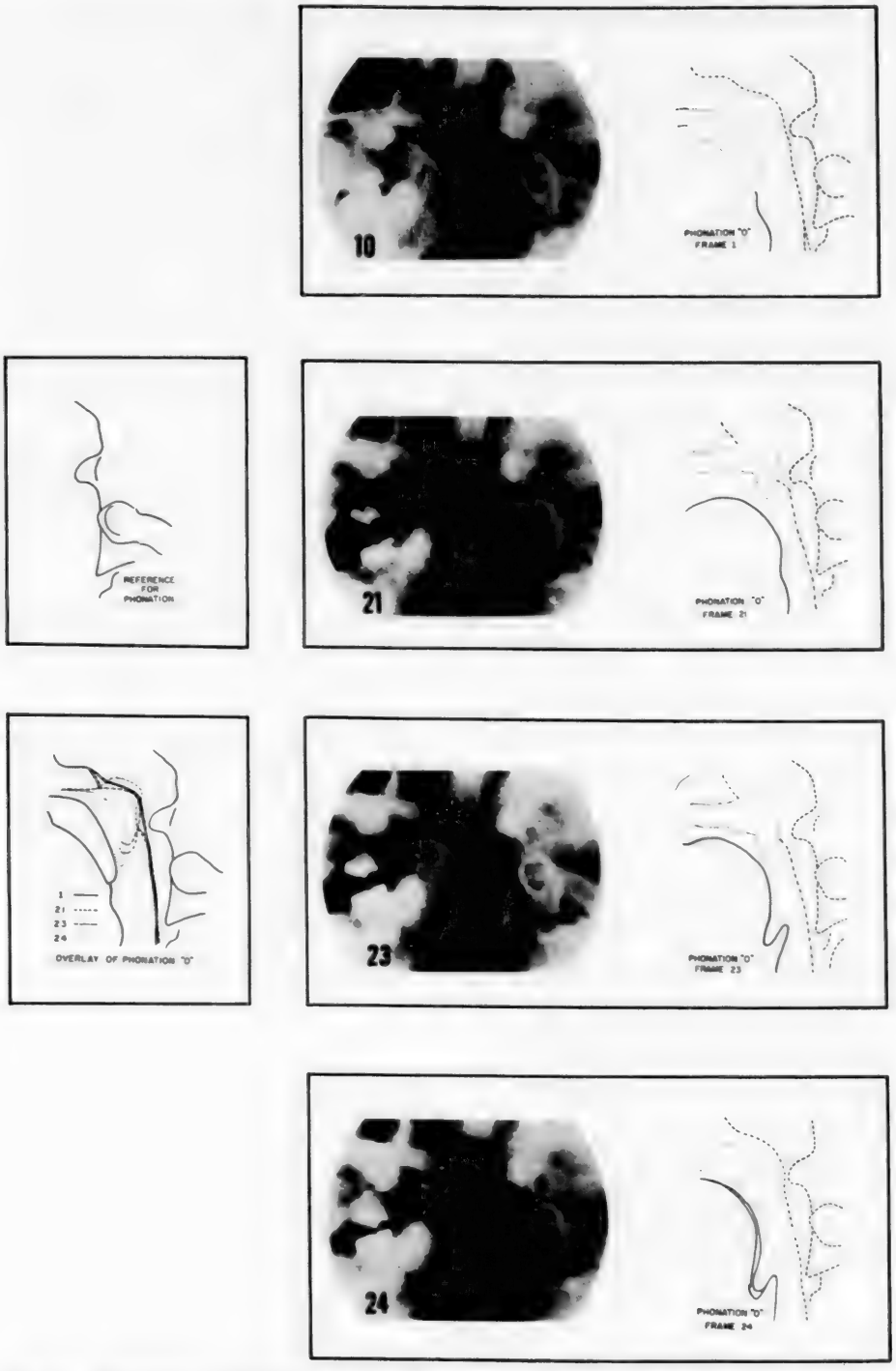

Fig. 2. Demonstrates sequences of phonation, comparing photographic enlargements and tracings of same frames.

cabinet, the single frame tracing step may optionally be completely by-passed; thus a considerable time savings is obtained. If the region being observed has a large number of moveable structures, however, the resulting overlay of images may be difficult to interpret without individual frames to which to refer. This can be partially overcome by sketching fewer frames per overlay. For checking movements of a single structure the area may be sketched in rest position then, by tracing only the structure under observation as successive frames are projected, a clear and accurate impression may be gained.

Because the soft tissue technique used in cinefluorography usually does not demonstrate skeletal details well, a reference figure for the overlay drawings may be advisable either from an especially clear frame or from a standard lateral x-ray film taken at a higher roentgen exposure.

To check the accuracy of the tracings, photographic enlargements of typical sequences can be made in a series of four frames on four by five inch cut film (Figure 2), then printed and mounted on a post card. The information concerning the physiologic activities of the structures under study thus is derived from consideration of material from multiple techniques of film analysis. It is felt that this method provides an adequate analysis of cinema film.

Summary

Methods of analysis of cineflourographic and standard motion pictures are briefly reviewed and a more complete procedure of tracing and analyzing motion picture studies is described. This employs a film editor, a modified motion picture projector, and a tracing cabinet designed for this purpose. It is felt that the use of this method can provide information for diagnostic and research purposes which would not be otherwise available.

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MEDICAL AND BIOLOGICAL ILLUSTRATION

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A Simplified Technique for High Speed Flash Photography With the Phase Microscope

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THE rendition of sharply defined edges free from disturbing fringes is one of the distinct advantages of the phase microscope. (1) However, in many colloidal systems the size of the particle is such that "Brownian" motion is present. Measurement of particles sizes in this case is difficult or at least unsatisfactory. Apparatus and techniques are described elsewhere (1) for the photography of such samples but call for special electronic flash tubes and optical setups.

The following commercially available equipment has been successfully used with the American Optical "phase" microscope for making "electronic" flash photomicrographs:

American Optical Advanced Illuminator No. 135 Strobonar 1a or 1 Flash Lamp
Note (1)

Leica Camera and Micro-Ibso Attachment Neutral Filters, Inconel Coated Glass
Note (2)

Procedure

The simplicity of the techniques is due to the fortuitous construction of the "advanced illuminator" which allows the separation of the lamp housing from the lens system by loosening two thumb screws. When taking the "flash" pictures, they are left loose enough so that the lamp housing can be lifted off without disturbing the position of the light. An appropriate field is located by means of the focusing telescope of the Micro-Ibso and the flash lamp placed in position after the removal of the regular light as shown in Fig. 1. At the extreme left of the photograph is the regular lamp of the illuminator. Next the power pack and the flash lamp is shown in position being held by a clamp supported by a ring stand. In actual practice the flash lamp can be "hand held" in position. As shown in the illustration, the shutter of the Micro-Ibso is used to discharge the flash. Equally satisfactory exposure may be made by opening the shutter and operating the flash manually. Exposure is controlled by use of the appropriate "Inconel" neutral filter. As a guide, satisfactory negatives were made with the new Eastman Panatomic X film with the oil immersion N.A. 1.25 bright contrast-high objective. No filter was used and the ground glass diffuser of the illumination was left in position. Normal development of the negative in D76 was

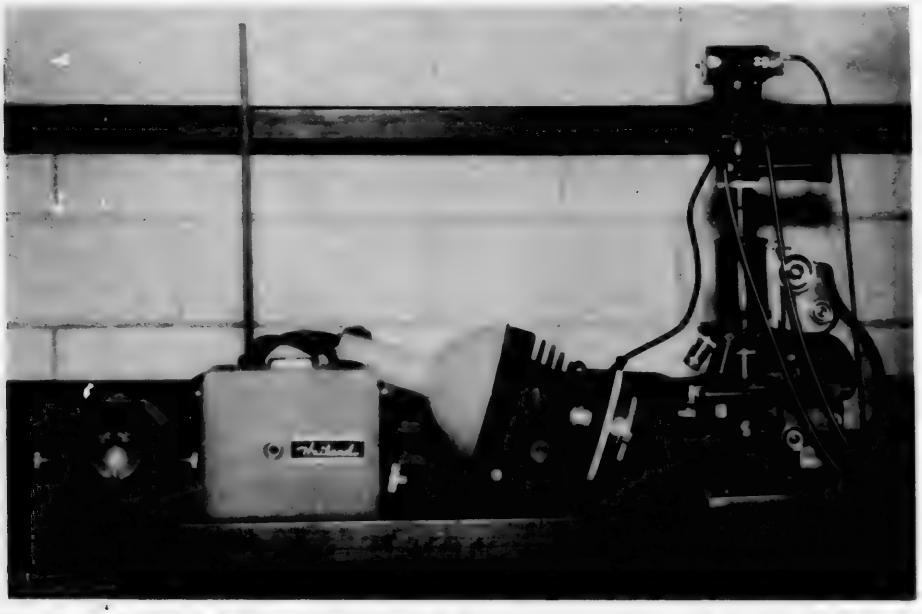

Fig. 1. Strobonar 1α in position for taking flash photomicrographs. Note regular light source at the extreme left of the photograph.

used, although greater contrast could be gained by increasing development time. The system could easily be made more elaborate by mounting the two light sources on a sliding bar or by using a flash tube with a "matching light" for focusing. Shorter flash duration or greater light output could also be used by changing the type of flash tube and power pack which is available.

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Note 1 supplied by Heiland Research Corp., Division of Minneapolis-Honeywell Corp.
Note 2 supplied by Bausch and Lomb Optical Co.

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Photographing the Interior of Honeycomb Cells

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RING-LIGHT techniques have been used for some time for shadowless lighting and for penetrating difficult areas where ordinary illumination would not give the required results. This article will very briefly describe a method for photographing the interior of a honeycomb cell using an electronic ring-light.

The problem was to evenly illuminate the inside of a particular cell containing the dried tongue of a dead worker-bee pupa. (disease: American Foulbrood).

Fig. 1 shows the Mighty Light Circle Flash mounted on a Kilfitt bellows with an Exakta VX in position for photographing this cell. Honeycomb cells are approximately 5 mm in diameter and 15 mm in depth, the tongue in this case being about 4 mm from the top. Because of the delicate nature of the cells, focusing is done with the aid of a small, low wattage bulb to prevent the wax from melting. It is positioned as closely as possible to the camera to achieve at least partial illumination of the point to be photographed. In this case, because of the close position of the camera lens to obtain a suitable magnification, a single source of light, regardless of how bright it is, cannot be used for photographing as it can illuminate only one side of the cell adequately. As the required angle is low, the light skims over the tops and does not penetrate into the cell. Even this "skimming" effect would not render a useful photograph at this focus position, as the top of the cell would be unsharp due to the shallow depth of field.

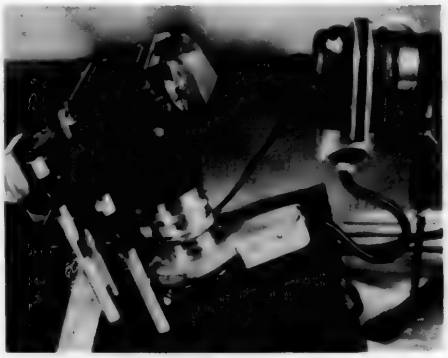

Fig. 1. Equipment set-up.

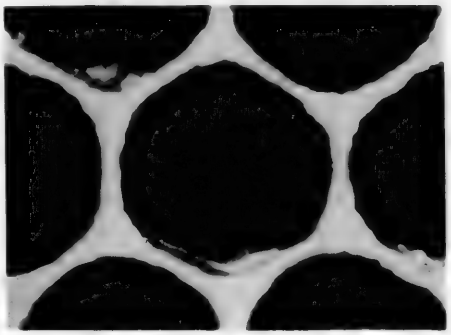

Fig. 2. Interior of cell showing tongue. Print magnification 4.9X.

Fig. 2, taken with the Circle Flash, shows the pupa tongue evenly and completely illuminated. As mentioned above, the cell top is unsharp at the magnification, which was 1.3X on the film. This technique does have its limitations, with this type of material, in the degree of magnification which can be achieved on the film and still have the subject well illuminated. A much larger image of the cell necessitates the lens being moved closer to the subject; the ringlight is then too close and the narrow angle gives only the skimming effect mentioned above.

Exposures were made on Kodak Panatomic-X at f.11, processed in Microdol for 6 minutes at 68°F.

ANNUAL AMERICAN MEDICAL WRITERS' ASSOCIATION NUMBER OF THE MISSISSIPPI VALLEY MEDICAL JOURNAL

The January issue of the MISSISSIPPI VALLEY MEDICAL JOURNAL (Quincy, Ill.) features the papers presented at the 14th annual meeting of the American Medical Writers' Association in St. Louis last September. These are interesting papers by Drs. Morris Fishbein, Austin Smith, Dean F. Smiley, Edward R. Finckney and Miss Ethel H. Davis, of Chicago, Prof. Jay R. Gould of Troy, N.Y., Dr. Joseph F. Montague of New York, Dr. R. Walter Schlesinger of St. Louis, Dr. J. P. Gray of Detroit, Mrs. Florence A. Cooksley of Washington, D.C., Mrs. Mildred Hoerr Lysle of Cleveland, Miss Lois DeBakey of New Orleans, Mrs. Ruth Good of Ann Arbor, Mich., Dr. S. O. Waife of Indianapolis; the winning papers in the 1957 Mississippi Valley Medical Society Contest by Dr. Wilfred Dorfman of Brooklyn, Dr. Ethan Allan Brown of Boston, and Dr. Earl J. Farrell of Newport, Ky., and three papers in the 1957 AMWA contest in non-medical writing by Mrs. Mildred Hoerr Lysle of Cleveland, Dr. Charles W. Sellers of Detroit, and Dr. Paul E. Craig of Tulsa, Okla.

In addition, this issue features an unusually interesting educational paper entitled, "Let's Improve the Curriculum in Our Public Schools", by Dr. Harold Swanberg, Secretary of the Writers' Association and General Chairman of the Quincy Major Learning Program. Swanberg advocates early identification of talented and gifted pupils in all communities together with the furnishing of sufficient incentives to induce them to pursue a college education. This is called a Major Learning Program. He also advocates radical changes in the curriculum of our public schools in an endeavor to help arouse a greater interest in scientific accomplishments and to help meet the challenge of the Russian compulsory fundamental educational system.

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Ways and Means of Reducing Your Operating Expenses

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Temple, Texas

From the Department of Photography of the Scott and White Memorial Hospital, Temple, Texas.

WHEN our work load and the need for color-photography were increasing constantly, it became necessary for us to investigate our methods to determine how we could operate more efficiently. For reasons of economy, it was not feasible (1) to employ additional personnel, (2) to increase the cost of operation, or (3) to discourage photographic services in any way. By our survey, we found that our results were satisfactory, but our techniques were time-consuming. We analyzed our situation, and sought ways and means to meet the increasing requests for photographic services and to reduce our operating expenses.

For clarification, we do institutional work. Our personnel consists of three employees: a photographer, an assistant photographer, and a lantern slide librarian and student photographer. (The lantern slide library was added to our department in 1952, and it now contains 10,000 lantern slides. We maintain this service in addition to our regular photographic duties.)

Figure 1 graphically illustrates our need for some time-saving procedures and for reducing our expenses. In 1950, 776 views were made and 466 lantern slides were produced. (A patient photographed in color and in black-and-white is considered as two views.) By 1951, the views had climbed to 2,055, and lantern slide production had reached 934. Through 1956, this work load continued to increase. Last year, we made 2,815 views and 1,468 lantern slides. An increase in volume was expected for 1957. Using 1956 as a basis for comparison, the same work load for 1957, employing our economy measures, will reveal a savings in material and in time. In this paper, the expenditures and savings quoted for 1957 are estimated on this basis.

By our survey, we learned that there were other more economical methods[1,2] for accomplishing the desired results, affording us new capacities for saving time without lowering the quality of our work. *Our basic change was from 3¼ x 4¼ inch cut film, color and black-*

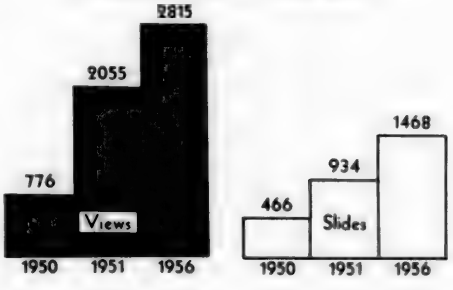

Figure 1

and-white, to 120 roll film for photographing all patients, all pathologic specimens, and for photomicrography. These improvements did require the purchasing of additional equipment. The old equipment was used wherever it could be employed to save time.

In our institution, most photographs are made for lantern slides, preferably in color.

Economy Measures

As a routine procedure, black-and-white prints, 5 x 7 inches, were made for filing on the clinical records. As our first economy measure, *we discontinued making these black-and-white prints for filing.* A form was substituted for the black-and-white print on the clinical record, and a rule allowing a ten-day-period for delivery of any necessary photographs was put into effect.

Because photographs sometimes are necessary on the clinical records, this need is being fulfilled by *attaching color-transparencies to the record sheets.* These transparencies can be produced at a cost of 28 cents, each—compared to a former cost of $4.76 for three 5 x 7 inch black-and-white prints. (This cost includes the labor and materials for producing the prints as they were being made.) The color transparencies are adequate and are an approach to placing colored illustrations on the clinical records. The black-and-white negatives are made and filed. Processing is done four rolls together, as time permits. Prints are made upon request, and prints from these negatives have been satisfactory.

During 1956, 2,250 black-and-white prints were made for filing on the clinical records. The cost of material for this phase of work was $135.00, and 250 hours of labor were required. By not producing these prints, we are saving 250 hours of time and $135.00 of material cost.

Photographing Patients: During 1956, 236 patients were photographed. There were 780 views, 390 were made in color and 390 in black-and-white. By changing from the cut film (material cost of $850.00) to roll film (costing only $249.00), a reduction in cost of production of $601.00 is being achieved. Twenty hours of time will be saved.

(Table 1)

ESTIMATED SAVINGS FOR 1957

236 Patients

Number of Views			Cost		Reduction	
Color	Black & White	Total	Cut Film	Roll Film	Cost of Material	Time (Hours)
390	390	780	$850.00	$249.00	$601.00	20
255 Pathologic Specimens						
360	360	720	$749.00	$230.00	$519.00	20
450 Photomicrographs						
225	225	450	$265.00	$ 42.00	$223.00	38
TOTAL		1,950	$1,864.00	$521.00	$1,343.00	78

Photographing Pathologic Specimens: During this same year, 255 pathologic specimens, 720 views (360 in color and 360 in black-and-white) were photographed. Using the roll film (costing $230.00) instead of cut film (at $749.00), our cost of production for photographing pathologic specimens will be reduced by $519.00. Again, we are saving 20 hours of time.

Photomicrography: Four-hundred-fifty photomicrographs (225 in color and 225 in black-and-white) were prepared in 1956. Cut film (costing $265.00) is being replaced by roll film (costing only $42.00). In 1957, the cost of production for 450 photomicrographs will be reduced by $223.00. Formerly, 76 hours were needed to make 450 photomicrographs. Now, we can save half of this time, 38 hours.

Flash Lamps Replaced by Electronic Flash: We formerly used a large number of flash lamps. This practice was expensive and time-consuming. We now use the electronic flash, and we have found this flash to be very helpful and time-saving. The ring flash also has helped to obtain *views* we formerly could not get.

(Table 2)

ESTIMATED SAVINGS FOR 1957

X-Ray Film Lantern Slides

Number of Slides	Cost Former Method	Cost Present Method	Reduction Cost of Material	Reduction Time (Hours)
300	$123.00	$ 84.00	$39.00	118
Tabular and Textular Lantern Slides (Negative)				
300	$ 69.00	$ 54.00	$15.00	66
Line Lantern Slides (Positive)				
100	$ 39.00	$ 24.00	$15.00	33
TOTAL	$231.00	$162.00	$69.00	217

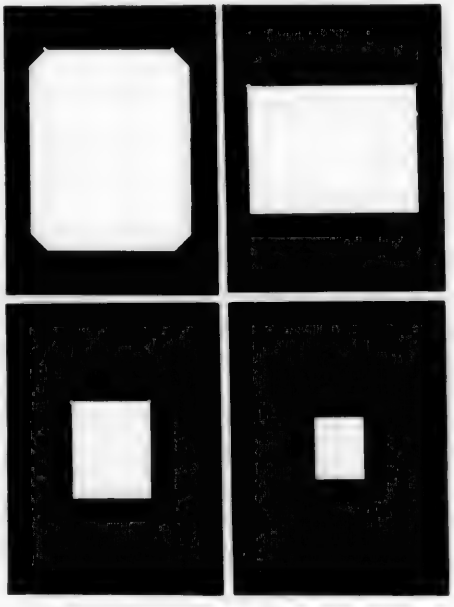

Figure 2

X-Ray-Film Lantern Slides: The reproduction of a roentgenogram always is tedious. Our former method was to make a negative on a 5 x 7 inch film. The lantern slide was produced by reduction, using lantern slide plates and a camera. Our present approach includes *standardization of areas to fit available, ready-made lantern slide mats.** Masks have been prepared (Fig. 2), and we suggest these openings to the doctor when the order for photographic work is received. (The doctors are encouraged to bring the x-ray films to the Photographic Department (Fig. 3) where we can select the areas and learn the pathology to be shown on the slide.)

Figure 3

Utilizing equipment on hand, we now make two negatives on one 5 x 7 inch film. The images are reduced to 3 inches for horizontal composition, and to 2⅞ inches for vertical composition. Using a camera (Fig. 4), positives are made from these negatives on a 1:1 basis (2 on one 5 x 7 inch film). Fine grain positive and contrast process ortho films** are the positive materials. Contrast control for the two-on-one slide is much better. The

bellows extension factor is constant for single slides. The positive is taped to a mask and bound between cover glasses in the usual manner.

(*Negative*) *Tabular and Textular Lantern Slides*: The negative lantern slide is preferred in our institution. Our orders for negative lantern slides range in number from 1 to 20 slides. Formerly, we used a contrast lantern slide plate for this work. With the usual developing and clearing in Farmer's reducer, our problems were: (1) getting the material straight on the slide, and (2) maintaining a good black background with clear letters. Handling always was slow.

Our change for preparing these negative lantern slides was to Kodalith film,* two negatives on one 5 x 7 inch film. The films are cut apart, taped to a mask, and

Figure 4

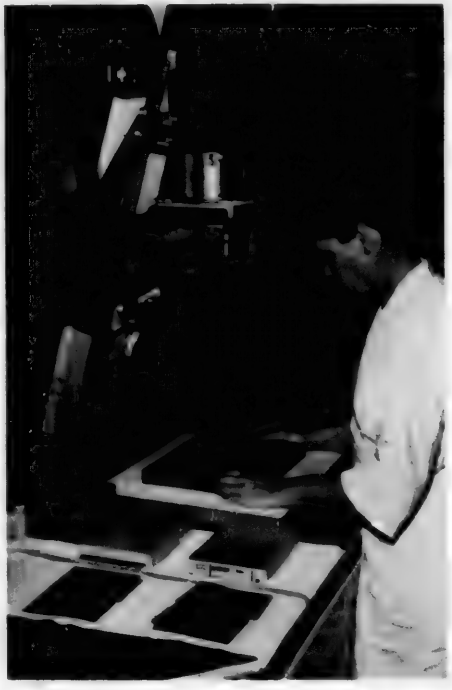

Figure 5

(Table 3)

PHOTOGRAPHIC MATERIALS

	Cost
Expenditures for 1956	$2,350.00
Estimate for 1957	$ 723.00
REDUCTION	$1,627.00
TIME SAVED	545 Hours

FLASH LAMPS

	Cost
Former Cost, Annually	$120.00
Electronic Flash, Amortized (10 Years)	$ 40.00
REDUCTION	$ 80.00

bound in the usual manner. We have eliminated the problem of crooked slides, and good black backgrounds are obtained. (*Positive*) *Line Lantern Slides*: The former method for positive line lantern slides was to make the negative on a 5 x 7 inch film. The positive was prepared by reduction, using contrast lantern slide plates.

Now, we use the 5 x 7 inch camera, making two negatives on one 5 x 7 inch Kodalith film. The positives are produced by contact on Kodalith film (Fig. 5). An enlarger is used as a controlled light source. Again, by using the film and masks, our problem of preparing straight lantern slides has been eliminated. Fixing, washing, and drying are accomplished, using 5 x 7 inch racks. Tribe[3] has an article on this procedure in the B.P.A. Journal.

Summary

In order to make the necessary changes, a program of cooperation and coordination was instituted. *To accomplish* your work efficiently, you must coordinate your efforts. *To coordinate* your efforts, you must obtain cooperation from the people you serve. *To obtain cooperation*, often it is not what you say, it is how you say it.

By instituting our program of cooperation and coordination and by changing our methods during 1957, our operating expenses have been reduced by $1,627.00 and 545 hours of time have been saved.

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1. *Kodak Data Book on Slides*, Ed. 4, Rochester, N.Y., Eastman Kodak Company, 1952 (1953 Printing).
2. *Photographic Production of Slides and Film Strips*, Rochester, N.Y., Eastman Kodak Company, 1955.
3. Tribe, H. E.: A Method for Making Quality Line Lantern Slides Economically, J.B.P.A. 24:72-75, May, 1956.

PRESIDENT'S MESSAGE

Greetings!

It is with a great deal of humility that I assume the Presidency of this Association. I am mindful of the growing importance of audio-visual aids in all the fields of education. Biophotography is alive with new developments and expanding areas of operation. Hence it should be the aim of all of us to be alert and keep abreast of the ever developing techniques in our field. Of equal importance is to keep management posted on these advances. We should then sell ourselves as the logical ones to operate and control these added assignments. Coordination and efficiency of audio-visual aids can not be achieved when their control and operation is scattered throughout various departments.

We are well on our way toward bringing our Journal up to date. Your patience is appreciated and we ask for your continued cooperation in order to achieve our aims. Many of us have been somewhat lax in submitting manuscripts to the editor. Remember this, that a technique that seems routine to us might be of important help to someone else. Why not sit down now and prepare that paper.

Because I am attempting to serve our Association in a dual capacity as President and Editor, and because I believe our society is becoming more important day by day, I have asked our Vice President, Verlin Yamamoto to assume the administrative duties pertaining to all committees. He has accepted and I am grateful.

If we can be of any help to you, feel free to let us know.

LEO C. MASSOPUST

New Products

NIKON INC. SPONSORS PHOTO TOUR OF ORIENT

Hawaii, Tokyo, Kyoto, Toba, Hong Kong, Thailand, Singapore, and the Philippines form the exotic itinerary of a photographer's tour of the Orient which begins next April 25 from San Francisco. The tour, to be conducted personally by Arthur Rickerby, noted United Press staff photographer, is sponsored by Nikon Inc., sole U.S. agency for the Nikon SP and S-2 cameras and Nikkor lenses. Travel during the tour will be via Pan American Airlines.

The tour will reach Japan in Cherry Blossom time, which provides countless opportunities for photography. A Japanese theater will be visited, where lensmen will be able to shoot the brilliantly costumed stage action. Complete sightseeing trips to the beautiful parks, shrines, temples, and natural wonders of Japan have been arranged. Comprehensive sightseeing trips in the cities of Hong Kong, Bangkok, and Angkor Wat will provide unusual material for creative photography.

A highlight of the tour is a full day visit to the Nippon Kogaku KK plant in Tokyo. This is the plant where the Nikon Camera and Nikkor lenses, as well as some of the world's most advanced optical scientific instruments are made. Visitors will see the glass laboratories and will actually watch the building of the world-famous Nikon cameras.

Those interested in the tour should contact Nikon Inc. at 251 Fourth Avenue, New York 10, N.Y. or the agent for the tour, the Piero deLuise Travel Agency at 2355 East 3rd Avenue, Denver 6, Colorado.

NATURE AND WILDLIFE PHOTOGRAPHY BROCHURE AVAILABLE

Photographers interested in taking pictures of nature and wildlife will find some very authoritative and interesting facts on the subject in a new brochure titled, "Operation Squirrel".

Written by J. E. "Jake" Johnson, a staff photographer with the Florida State Commission of Game and Freshwater Fish, this brochure covers this photographer's approach to animal photography. Mr. Johnson informs the reader that amid natural settings as in the woods or in a forest, the photographer should exercise a measure of common sense . . . that he should not put himself too close to an untamed, unpredictable subject, as in this case, an animal.

Exposure settings for color and black and white film for wildlife shots are given by the author, with emphasis placed on the fact that animal pictures should not have a "frozen look" if they are to appear natural.

There is more good advice for the aspiring wildlife photographer including the necessity for an absolutely dependable camera.

This remarkably comprehensive brochure is available free of charge, upon request, from Exakta Camera Company, 705 Bronx River Road, Bronxville, N.Y.

WORLD'S SMALLEST ELECTRONIC SPEEDLIGHT

The new RECTABLITZ miniature speedlight offers a guide number of 35 for Ektachrome (flash speed 1/500th sec.) with perfectly uniform light distribution, yet weighs only 1½ ounces and is smaller than a pack of cigarettes: 1x1½x1½"!

The handsomely designed unit slips comfortably into the accessory clip of any camera, without any noticeable increase in weight. A built-in spring clip or a special clamp attaches the reflector to any camera case, shoulder strap or the photographers coat lapel. The RECTABLITZ is also available with a special shoe, fitting it to the Minox camera without synchronization cord.

The compact powerpack comes in an attractive leather case with built-in testlight and takes three standard 1.5 volt dry cell batteries. A simple extension cord permits operation on 110 volt A.C.

A special three-section bracket allows the miniature reflector to be placed extremely close to lens and subject, which makes the RECTABLITZ also the ideal unit for Macrophotography.

Distributed in the U. S., exclusively by Karl HEITZ, Inc., 480 Lexington Ave., New York 17, N. Y., through franchised dealers, the RECTABLITZ retails for $69.90 and with special shoe for the Minox for $75.90.

KERN SWISS POCKET SIZE PRISM MONOCULARS

Designed with convenience in mind, these compact and featherweight, but shockproof monoculars are perfectly suited for sports events, for hiking, for theater and opera, etc. as well as for the ladies — wherever pocket portability is essential.

Precision ground KERN prisms and lenses with all-surface-coating render striking overall brilliance and provide critical focusing, finest details and highest contrast.

The rugged Swiss precision mechanism eliminates costly or impossible repairs. A simple adapter-ring allows the Kern Swiss monoculars to be used as telephoto lenses with an ALPA 35mm single-lens reflex camera. They can be easily focused with ONE hand by a simple thumb movement.

As well as the Kern Swiss Prism Binoculars, these monoculars carry an unconditional guarantee for highest optical performance.

Distributed by Karl Heitz, Inc., 480 Lexington Ave., New York 17, N.Y.

Prices include leather case and range as follows:

6x24, $39.00; 6x30, $51.00; 8x24, $48.00; 8x30, $57.00; 12x50, $89.00 and the 3 ounce (!) 8x18, $44.00.

ALPA ALL-IN-ONE LENS FOCUSES FROM INFINITY TO 2"

The New ALPA MAKRO-KILAR 40mm 1/2.8 with preset diaphragm now available with the Swiss ALPA 35mm single-lens reflex camera, is an ideal lens for universal use.

The extreme extension range of the lens mount allows continuous through-the-lens FOCUSING FROM INFINITY DOWN TO 4" (model E) OR 2" (model D) WITHOUT ACCESSORIES. With ONE turn of this lens you "zoom" all the way from infinity and panoramic views — to medium range for family and group pictures — to wide angles for architectural and interior shots — to ultra close-ups of any small object.

Calibrated on the lens are distances, exposure factors and subject-to-negative ratios of up to 1:2 or 1:1 (!) respectively, which are further increased when enlargements are made from the negative or in screen projection. Both filter-holder and lensshade are built right into the lensmount.

Every one of the new ALPA MAKRO-KILAR lenses is twice individually tested — by the lens manufacturer as well as in the ALPA factory — and carries an unconditional guarantee for highest optical performance.

Distributed in the U.S. by Karl HEITZ, Inc., 480 Lexington Ave., New York 17, N.Y., through franchised dealers, the preset ALPA MAKRO-KILAR E (inf. to 4") retails for $119.50, with ALPA 4 (Straight Reflex) for $279.00, with ALPA 5 (Prism Reflex) for $349.00, with ALPA 6 and 7 (Prism Reflex plus Rangefinder) for $385.00. Prices for the ALPA MAKRO-KILAR D (inf. to 2") $20.00 higher.

LEATHERETTE CO' ERED CASE FOR NEW SCREEN BEAUTY

A new idea in projection screen design has just been announced by the Radiant Screen Company of Chicago, Illinois.

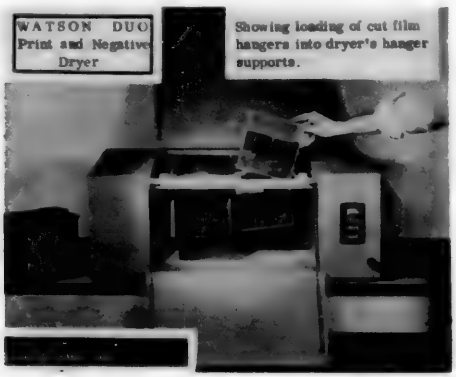
The screen case of the new IMPERIAL SCREENMASTER by Radiant is now leatherette covered: The blue covering is permanently bonded to the metal case and cannot be scratched, chipped or peeled. It is an entirely new concept in metal finishing and gives a truly decorator appearance to the screen.

To tie in with the leatherette covering and lend further color harmony to the entire screen, the picture border area on the production surface is now done in a blue to match the leatherette.

The fabric of the IMPERIAL SCREENMASTER is Radiant's new exclusive UNIGLOW. A recent Radiant development, UNIGLOW is brighter than a beaded surface when viewed from the projection axis and remains much brighter when viewed from as much as 45 degrees off the projection axis. Thus, UNIGLOW provides a 90 degree picture viewing area, almost twice as much as any surface has provided before. In addition, UNIGLOW is completely free of grain, thus giving much greater resolution.

The Radiant IMPERIAL SCREENMASTER is made in eight convenient sizes from 30"x40" through 70"x70".

For further information, contact: Milt Sherman, Radiant Manufacturing Corp., Post Office Box 5640, Chicago 80, Illinois.



BURKE & JAMES DRYERS APPROVED BY TESTING AGENCIES

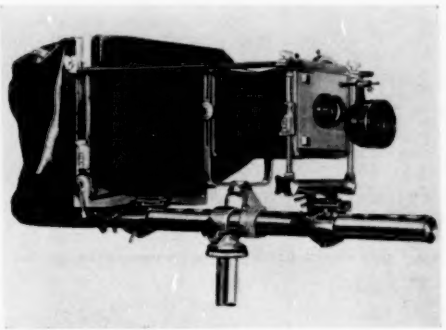
The Underwriters Laboratories and the Canadian Standards Association have granted seals of approval to the Rexo Double Duty Dryer Model 66 and the Dri-Master Dryer Model A. The Watson Duo Negative Print and Print Dryer, recently introduced, is now U.L. approved.

Exhaustive tests by these organizations have found that B & J dryers meet their exacting re-

quirements for safety of design and quality of components.

The Rexo Double Duty Print Dryer has two 19x25" stainless steel drying surfaces, with a capacity of 750 2¼ x 3¼" prints per hour. It features a new damage resistant Unicoil heating element, thermostatically controlled for even heat, 110 V. 60 cycle AC model is $66.95. The Dri-Master is a table-top unit with a single 19x25" stainless steel platen. It also features the Unicoil heating element with thermostatic control. Capacity is 375 2¼ x 3¼" prints per hour. 110V AC model is $44.50.

The Watson Duo, newest unit in the line, holds up to 125 sheet film negatives 5x7" or smaller or 80 8x10" negatives. 2 Quiet double blower draws filtered air, warm or cool as desired, through dryer, dries film or prints quickly, evenly. Insertion of blotter pack (included) converts units to a print dryer with capacity of 150 8x10" prints per load. Dries prints gently, with minimum curl. Other features include Unicoil heating element, standard size air filter and built-in film hanger supports. Price with standard blotter pack is $114.50. With deluxe pack $135.00.



SINAR EXPERT 8 x 10"
INTERCHANGEABLE VIEW CAMERA

This unique precision camera — which is built and used daily by one of Switzerland's most famous professional Photographers — incorporates all desirable features of the large size Viewcamera, i.e. unexcelled versatility, light weight, compactness, easy interchangeability of components PLUS dual application of most SINAR accessories.

Both front and rear frames offer extreme swings and tilts, supplemented by graduations with zero centering marks, rapid tightening controls and leveling gauges for accurate positioning. Micro-gear operation makes both coarse and fine adjustment smooth and easy — with all controls at the photographer's fingertips, for either left or right hand operation.

Built-in registration pins and Multicolor 8x10 plate holders with inserts allow the camera to be used for color separation as well.

The special wide-angle bellows allows the use of extreme wide angle lenses (75!) and doubles as a viewing and focusing hood with attachable magnifying glass.

The non-vignetting 26" bellows can be supplemented by an extension bellows for telephoto lenses of unlimited focal length, which may also be used as a lensshade.

The auxiliary frame is primarily employed for attaching this extension bellows, but can also function as a focusing stage for close-up or copy work, for mounting a mirror to take shots at a 45° angle, for masks to make double exposures, etc.

Stabilizing rods are suitable both for color separation and to increase vertical rise.

The SINAR's unique flexibility allows its conversion from an 8x10 into a 5x7" or 4x5" view camera within minutes, by merely interchanging back and bellows.

Complete collapsibility of the unique lightweight metal construction results in a compact unit weighing only 17 lbs., which may be easily transported or stored in the convenient SINAR carrying suit case.

Distributed in the U.S. exclusively by Karl HEITZ, Inc., 480 Lexington Ave., New York 17, N.Y., through franchised SINAR dealers, the complete SINAR EXPERT 8x10" lists for $929.00, while the basic unit, the SINAR STANDARD 8x10", is priced at $649.00.

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FELLOWSHIP PROCEDURE

Members may propose for Fellowship in the BPA other members whom they consider worthy of recognition. To be eligible for Fellowship a candidate must have been a member of the Association for five consecutive years and must possess one or more of the following qualifications:

Superior craftsmanship in still or motion picture photography of biological subjects.

Ability in photographic research in new methods or materials.

(These require submission of evidence.)

Meritorious contributions to biological photography overall through sustained organizational work.

Two sponsors are required. The sponsors should be well acquainted with the candidate's work and ready to furnish the Board with details of his experience and achievements. Those who wish to sponsor a member whom they believe to be eligible should request a Fellowship Application form from the Secretary of the Fellowship Committee: Mrs. Maria Ikenberg, University of Illinois, 904 W. Adams Street, Chicago 7, Illinois.

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